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THE PRACTICE

OF

VETERINARY SURGERY

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VOLUME I

OPERATIVE TECHNIQUE

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PREFACE.

TEN years ago, whilst studying in Milan, I was invited to undertake certain duties as demonstrator and teacher at the Royal Veterinary College, London. Although finally I was unable to accept the terms of invitation the proposal so far influenced me as to bring about a species of mental stock-taking, the first result of which was the discovery of my own lamentable ignorance regarding much that I had been asked to impart to others; the second, a resolution to amend this state of things as soon and as thoroughly as possible. The work I then undertook has been helpful to myself, and I have reason to believe that the portions published have not been without value to others. The present effort is perhaps of a more ambitious character than its predecessors, and aims at furnishing English readers with a concise account of the most recent views regarding the practice of veterinary surgery from the standpoint of both British and Continental authorities. It will be divided into three volumes, of which this is the first; the second volume will deal with General, and the third with Regional Surgery. The second and third volumes are now in hand, and I trust that one, at least, may be published shortly. Regarding that now submitted, however, I trust no one will be deceived into ascribing to me greater merit than I possess. Veterinary science has become too specialised for any writer to rely solely on his own experience, and, like many much more eminent men, I have found my chief usefulness less in enlarging than in rendering available existing stores of knowledge. It is true I have satisfied myself to the best of my ability of the soundness of the views put forth,

and I desire to be held responsible for everything I say, but otherwise my position is really no more than that of an expositor.

On the other hand, my indebtedness is manifold. For the use of illustrations, and for leave to extract such portions as seemed suitable from his masterly 'Operationslehre,' I have to express my deep obligation to Professor Dr. Bayer, of the Vienna Veterinary School. I have taken full advantage of his permission. For information in regard to French practice I have frequently had recourse to Professor Cadiot's 'Traité de Thérapeutique Chirurgicale,' while I have received much assistance from Professor Lanzillotti-Buonsanti's 'Trattato di Tecnica e Terapeutica Chirurgica degli Animali Domestici' and from the 'Lehrbuch der Chirurgie für Thierärzte' of my old friend and esteemed teacher Professor Dr. Möller. Regarding human practice I have consulted the well-known 'Manual of Surgery' of Messrs. Rose and Carless.

The extent to which I have been able to illustrate the work is due in no small degree to the liberality of Herr H. Hauptner, Luisenstrasse, Berlin, and of Messrs. Arnold, West Smithfield, London, two of the largest veterinary instrument makers in the world.

Once more I have the sincere pleasure of expressing to Professor Macqueen, of the Royal Veterinary College, London, my gratitude for greatly valued assistance in reading proof-sheets, for general criticism on disputed points, and for never-failing support and encouragement in prosecuting the work now concluded.

JNO. A. W. DOLLAR.

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CHAPTER I.

GENERAL REMARKS ON OPERATIONS.

The word operation covers all mechanical interference undertaken for surgical purposes. Perfect restoration of function being usually demanded in veterinary surgery, many operations common in human practice must either be renounced or very seldom performed, partial recovery being worse than useless from the owner's standpoint. It is therefore often necessary to consider whether operation is justified or whether slaughter be not preferable. Owners as a class have quite erroneous impressions of the results to be expected. Many are not satisfied even when the animal's usefulness is completely restored because perhaps a trifling blemish remains. Some seem incapable of understanding that a certain time is necessary for recovery. They imagine that healing can be forced, become impatient, and in a few moments destroy by clumsy interference, or too early use of the animal, the results of weeks of skill, afterwards seeking to hold the operator answerable. In veterinary surgery the conditions for rapid healing are much less favourable than in human practice. The imperfect sanitary surroundings, the confinement in an air thick with micro-organisms, the active opposition of the animal, and the impossibility of shielding the wound from injurious external influences, as in human surgery, often render success impossible even with the greatest care and fullest perfection of detail.

Division.—Operations are divided according to varying circumstances. Those requiring the use of the hands alone are sometimes known as manual operations; the terms dressing and instrumental operations explain themselves. We speak also of elementary or compound, bloodless or sanguinary, regular or irregular; of urgent

operations and operations which may be deferred; of operations on the skin, the muscles, bones, tendons, and so forth; operations on the head, neck, trunk, etc., names which require no explanation. Urgent operations are such as cannot be postponed without gravely endangering life.

The indications and contra-indications for operation must be carefully studied. Beginners are not infrequently over hasty in this respect. For instance they declare an operation indispensable; the owner refuses his consent, and nevertheless healing results under simple treatment, or even without any treatment at all. The cliniques are perhaps somewhat to blame for this, as only severe cases which must be operated on are usually brought there, and even though in each case the special grounds which render operation indispensable are set forth, the student is apt to retain only a general impression, such as of a tumour and of the subsequent operation, forgetting the explanatory remarks. Such mistakes are made at first by everyone. Except in the case of urgent operations, like tracheotomy, operation for strangulated hernia, etc., it is first necessary to carefully consider whether the animal's value, its chance of perfect recovery, and the probable duration of its convalescence, justify operation at all. The need for operation and the dangers it implies must be clearly placed before the owner. A wise practitioner, however, will not, except in very urgent circumstances, insist on immediately operating for fear of prejudicing his client, but after a moderate expression of opinion will wait, knowing that the failure of other means will finally force the owner himself to demand operation. Definite promises should never be made in order to gain the owner's consent, for, considering the extreme variability of wound-healing, results can never be foretold with absolute certainty. When it can only have a temporary good effect and the disease is likely to return, when improvement is only to be obtained by sacrificing the animal's usefulness, or when the patient's strength is too greatly reduced, the practitioner's duty is clearly to deprecate operation even if called upon to perform it. In the last connection dogs suffering from generalised cancer are often submitted for operation in an extremely emaciated state. Should they die under the operator's hands the fact is related to the surgeon's discredit without any reference to the other circumstances.

Planning the Operation.—Before performing any operation the operator should mentally enact the details of each of the proposed stages. I will attempt, for instance, to suggest the mental process before the extirpation of a tumour. The tumour is situated thus . . . . . ; its relations are . . . . . ; it is of . . . . . character. It is situated near the

surface; I can therefore enucleate it. For this purpose I require the following instruments . . . . . To reach it I must divide . . . . . ; How shall I fashion the primary incision to insure free exit to discharge, to prevent the wound gaping, and to promote healing . . . . . ?; During dissection I may injure important structures, for instance . . . . . ; should this happen what must I do immediately . . . . . ?; what shall I require for the purpose . . . . . ? If division of blood-vessels is unavoidable I must check bleeding by ligation or torsion of . . . . . vessels; dressings must afterwards be applied to promote healing by primary intention over as large an area as possible; how can this be best effected ?; where shall I insert the drainage-tube ?; is it possible to apply a dressing, may it not in reality do more harm than good, and should not I attempt to protect the wound in some other fashion ? Such a mental process is unconsciously performed before the simplest operation, but only when rare and difficult operations are projected does its necessity force itself on our recognition. In very difficult cases operation may previously be performed on the dead body and the anatomical conditions noted.

During the above process one also determines the method of operation, for one method does not suit every case and it must be left to the ability of the operator to select the method he regards as being the best suited to the case in hand, the simplest to practise and as promising the desired result in the shortest time. Circumstances arising during the operation itself often necessitate unforeseen modifications, and test to the utmost the operator's resource and ingenuity.

The instruments selected must include not only those required for the operation itself, but for all complications which may possibly arise. At the same time the simpler they are, *cæteris paribus*, the better.

Preparation of the Animal.—Great importance used formerly to be attached to the preparation of the animal, which was bled and purged *secundum artem*. Such methods are now nearly obsolete, and the chief precaution required is to avoid casting an animal with a full stomach, overloaded bowel, or distended bladder, although the fear of rupturing the stomach, bowel, or bladder has been greatly exaggerated, as is proved by the small mortality in animals cast for urgent operations without reference to the state of the bowels, etc. It is however certainly advantageous to regulate the diet for a day or two beforehand.

The seat of operation should be thoroughly cleansed, the hair shaved off, and in the case of operations on the foot a local antiseptic bath may be given.

Operations become necessary at all times of the day, but when a choice is available the best time is probably the morning, as any

unfavourable sequelæ, like secondary bleeding, are more easily discovered and dealt with then than in the late afternoon or evening.

Recovery is often favoured by turning the animal to grass, for which reason spring is a very good time to choose when an option exists. The extremes of temperature occurring in winter and summer are disadvantageous. Great heat favours putrefactive processes in wounds, and flies, besides irritating the animals, often infect the parts.

Place of Operation.—When no special operating room is available, some open well-lighted spot, sheltered from wind and dust, should be chosen. The ground should be covered with clean straw to the depth of eighteen inches or two feet. Litter should certainly not be used. For dogs an operating table covered with a thick plate of glass can be used.

It is never wise to operate in boxes. If the horse is lying and unable to rise it should be drawn into an open space.

Assistants.—In preparing for an operation sufficient reliable assistance must be provided. Each assistant should be carefully instructed beforehand in his duty, whether it be holding, casting, or fixing the animal. To command efficiently and preserve order the surgeon must thoroughly understand every detail himself, a knowledge which can only be acquired by actual manual performance. Students therefore should themselves have opportunities of casting horses, each taking command in turn, until all know their duties. In addition to the men required for holding, casting, and tying the horse, the operator requires an intelligent personal assistant. An expert is not always necessary ; a layman with some dexterity serves the purpose very well. This assistant should wash, shave, disinfect, and prepare the field of operation ; collect the needful instruments, hold retractors, sponge the wound, etc. ; but as he then comes in contact with the wound in nearly the same degree as the operator, the same precautions are incumbent on him as on the surgeon in relation to disinfecting hands, nails, etc. For extensive, complicated, and dangerous operations, however, such an assistant is inadequate. A qualified person is then almost indispensable, inasmuch as he should know immediately what to do in the event of dangerous complications arising ; what to compress, what to grasp, which instruments to hand, etc. There is often no time for the lengthened explanations a layman would probably require.

Operations like the removal of tumours, etc., are seldom very urgent ; the surgeon has full time therefore to make all necessary preparations and to arrange for the help of a fellow practitioner. Unfortunately however there appears to be an impression amongst many that the practitioner injures himself in the view of the owner of the patient

when he suggests a consultation with, or the assistance of, a colleague. I consider, on the contrary, that such a request is the best means of impressing on the owner the importance of the case, the difficulty of the operation, and the care which the practitioner is exercising. I am glad that many of the younger generation of veterinary surgeons are beginning to adopt this view and to imitate their colleagues in human surgery.

AFTER-TREATMENT.—In many cases the after-treatment is even more important than the operation itself. The animal must be carefully watched to prevent it tearing off the dressing, rubbing or biting itself, lying down, etc., while the temperature, condition of the wound, and its surroundings, etc., must be observed, so that any deviation from normal may be early remarked and precautions taken in time.

CHAPTER II.

MEANS OF CONTROL.

OPERATION, or even local examination, is often impossible without recourse to methods of restraint, of which an exceedingly numerous choice is available, depending on the species of animal and the operation to be performed. To begin with, the horse should be securely bridled or haltered and held by a reliable man, who will give his whole attention to the animal, and at once check any indication of vice by calling to the animal, or similar means.

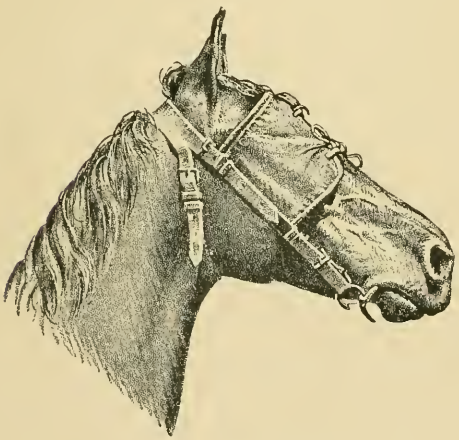

FIG. 1.—"The blinds."

Vicious horses may often be quieted by the application of blinds. Before casting, a special well-fitting winker bridle, the lower part of which can easily be removed, should be applied. The winkers should be padded and provided with straps, by which they can be brought together. By preventing it seeing, blinds often render the animal remarkably tractable, while they also protect the eyes when the animal falls, and whilst it remains on the ground. Some persons use a sort of leather cap or hood, which is drawn over the animal's head. Some arrangement of the kind is indispensable when horses have to be cast. A substitute may be extemporised from a thick piece of cloth doubled several times, passed over the eyes, and fastened to the back of the bridle.

Horses which bite may be muzzled.

To divert the animal's attention from the local pain, twitches are often

applied to the upper or lower lip, or to the ear. They produce most effect on well-bred horses. The simplest and most frequently used twitch is formed of a strong cord, threaded through the upper end of a stout rod.

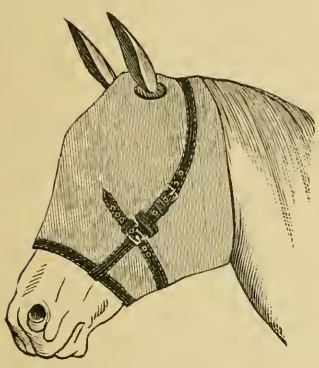

FIG. 2.—Operating cap or hood.

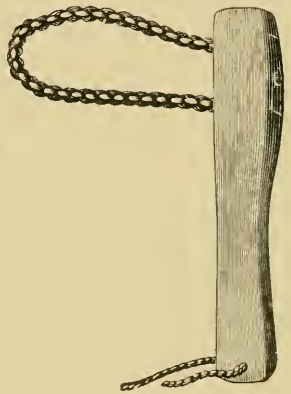

FIG. 3.—The twitch.

FIG. 4.—"The bulldogs."

The end of the rod furthest from the loop is provided with a cord, by which the twitch, when applied, may be attached to the cheek-strap of the bridle. This obviates the necessity for a man holding it. The rod must never be fixed on that side of the face on which the animal will fall when cast, and on which it may then continue to lie for some time. When dealing with very troublesome horses, the twitch stick may preferably be much longer, say six feet, and of proportionate thickness. It is then held by a man, who thus gains a considerable leverage over the horse, and is better able to control it. Neither iron "bulldogs" (Fig. 4) nor the loop twitch (Fig. 5) are to be recommended. The loop twitch not infrequently causes tearing of the angles of the mouth, and may so bruise the sides of the cheek that pieces slough away. A very much better twitch is formed by passing the loop under the horse's upper lip, so that it lies above the upper incisors. This controls the animal almost as effectually, and is not likely to produce a blemish.

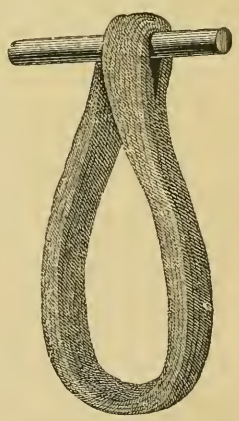

FIG. 5.—The leg-twitch.

The leg twitch is shown in Fig. 5. A stout piece of rope, about twenty inches long, is formed into a loop, through the open ends of

which a wooden rod is thrust. This is applied to the hind limb, about four to six inches above the hock, and is tightened by twisting the rod.

It being impossible to apply the ordinary cord twitch to the ox, a kind of forceps is used, which grasps the lower section of the nasal septum. The bull-holder, as this is called (Fig. 8), is provided with loops at the free ends of the handles, by means of which it can be secured to the animal's horns. In the bull-holder shown in Fig. 9 pressure is applied by means of a screw.

Nose-rings may here be mentioned; the most convenient are those which can be inserted without the assistance of an instrument. Hauptner's pattern (Fig. 10) is very practical. It consists of two semi-circular pieces connected by a hinge; one end is pointed and cutting, for the purpose of transfixing the nasal septum; this fits into a corre-

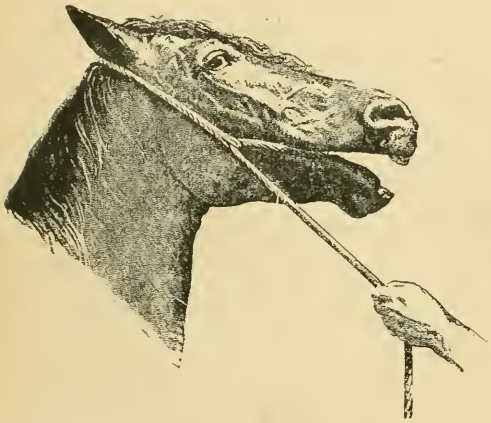

Fig. 6.—The loop twitch.

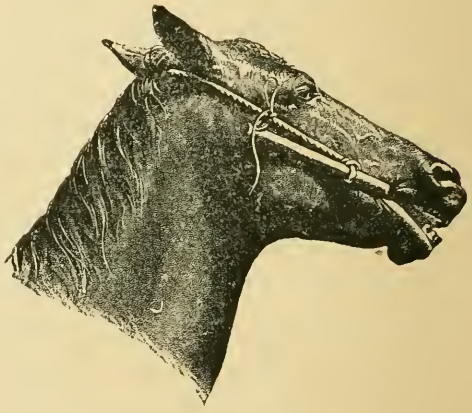

Fig. 7.—The loop-twitch tightened by inserting a wooden rod.

sponding depression in the other end, and is provided with a notch to receive the spring catch shown in the figure. Figs. 11 and 12 represent leaders for animals in which these rings have been inserted.

To means of restraint also belong gags—instruments for holding apart the jaws to allow of examining or operating on the cavity of the mouth or pharynx without danger of being bitten. Some are fixed, others movable, the latter allowing the mouth to be more or less opened as desired. One of the simplest forms of fixed gag consists of a heart-shaped piece of iron with two transverse branches fixed about four inches apart. It is thrust into the mouth horizontally until the upper cross-piece comes in contact with the upper molars, and then rotated so that the upper cross-piece remains in contact with the interdental space and the animal's chin lies in the lower rounded space. Movable gags are

preferable. The principle is similar to that above described, but the distance apart of the two transverse pieces may be altered by

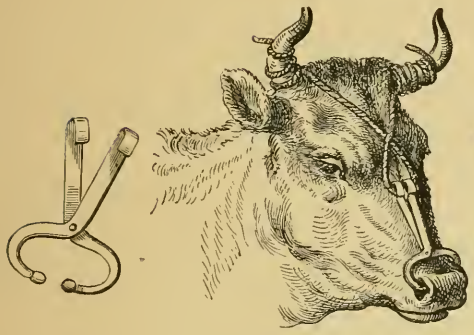

FIG. 8.—Bull-holder.

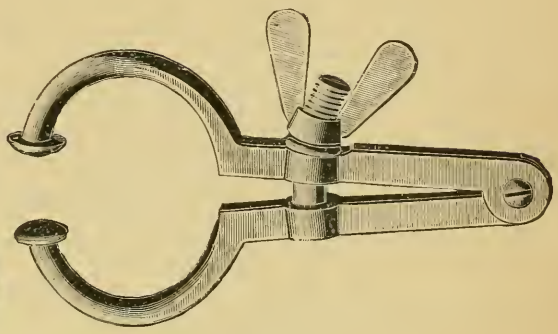

FIG. 9.—Bull-holder.

means of a screw. Brogniez's gag has a semicircular bar, which connects the horizontal branches resting in the interdental space of the upper and lower jaws respectively, and which may be moved to either

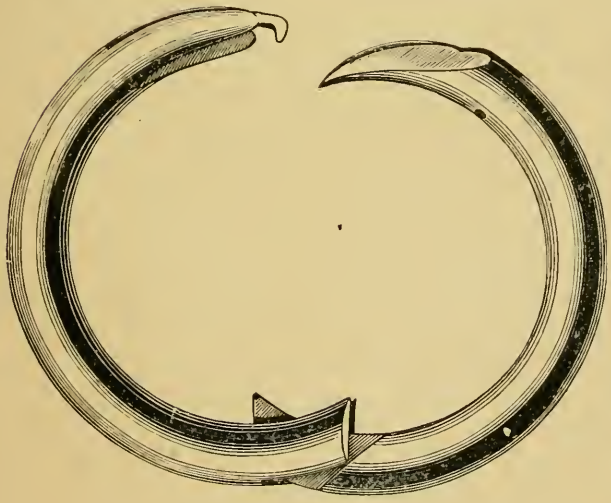

FIG. 10.—Nose-ring for bull.

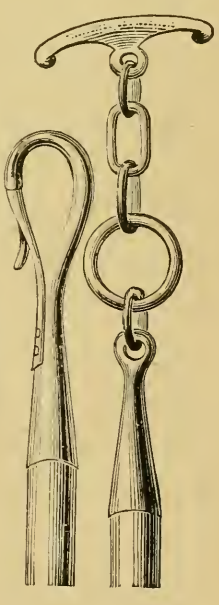

FIG. 11. FIG. 12.
Bull-leaders.

side. This gag has the disadvantage of requiring to be very strongly, and, therefore, heavily made, though it certainly leaves the mouth very

clear for operation. Mackel's gag is lighter, and does not require to be fixed with the hand. The upper and lower horizontal branches are

FIG. 13.—Showing the application of nose-ring and bull-leader.

separated by the rotation of movable nuts screwing on the two vertical connecting rods. Fig. 14 is Varnell's form. The transverse bars are covered with india-rubber. Until recently it was by far the most popular

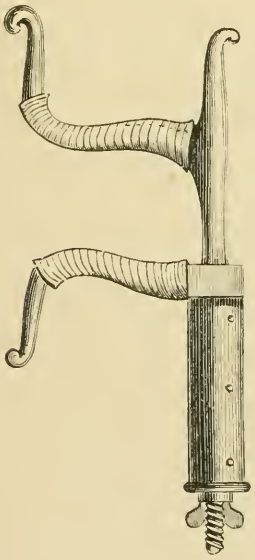

FIG. 14.—Varnell's mouth-gag.

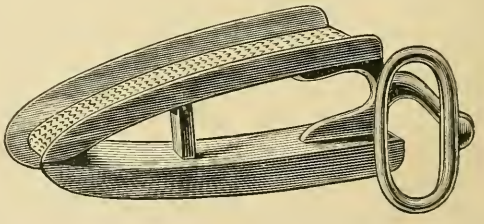

FIG. 15.—Bayer's mouth-gag for horses and oxen.

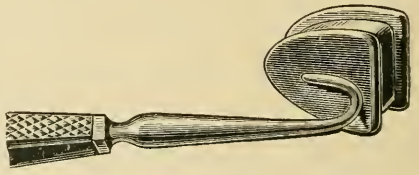

FIG. 16.—Bayer's mouth-gag for dogs.

form in this country. Fig. 17 is a design of Hertwig and Fuchs, so modified by Joger as to render it very portable.

During prolonged operations the gums become severely bruised, even when the transverse bars of the gag are well covered with rubber. To avoid this, Prof. Bayer, of Vienna, makes the grinding surface of the molar teeth themselves the point of support for a gag. This gag is

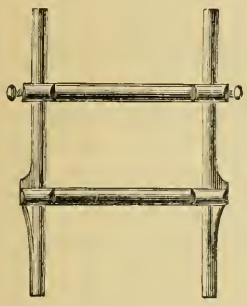

FIG. 17.—Joger's mouth-gag for horses. This apparatus can be dismounted and packed in a very small space.

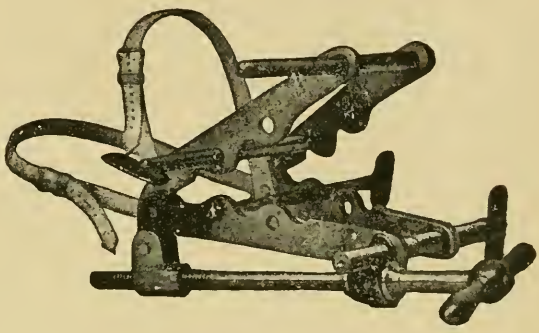

FIG. 18.—Woolf's mouth-gag—new form.

shown in Fig. 18, which will be seen to closely resemble that used for many years in operations on the mouth in man.

It consists of an upper and lower portion, each provided with guides for retaining the instrument in position on the respective rows of molars. The two portions are inclined towards each other at an angle of about

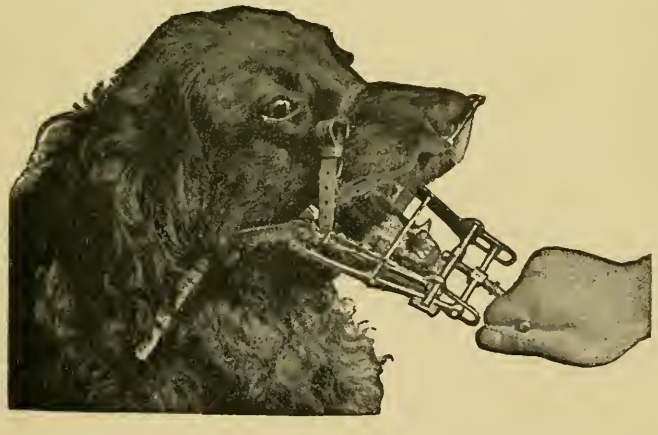

FIG. 19.—Woolf's mouth-gag—old form.

15 degrees. The back carries a handle for inserting the gag in place. The surfaces of the two plates being roughened, after the manner of a rasp, assist in holding the instrument firmly when pushed between the upper and lower molars. In use the animal's tongue is grasped with

one hand and withdrawn, the instrument held firmly in the other hand is then introduced into the mouth and pushed between the upper and lower rows of molars as far as it will go. The instrument should be steadied in position with one hand, whilst with the other the examination is made. As the operator himself controls the gag, he has ample warning to withdraw his hand in case of danger. Haussmann's mouth-gag for horses (Figs. 20—22) is probably the best and most convenient.

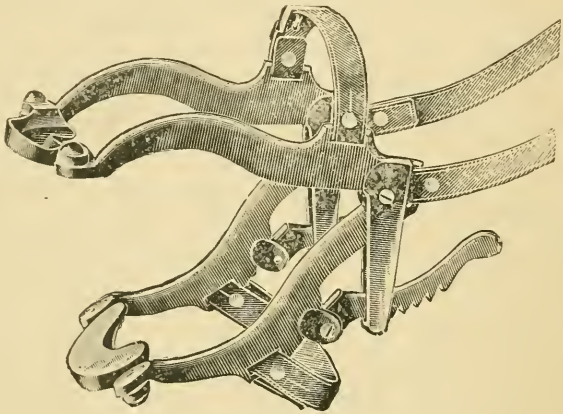

FIG. 20.—Haussmann's mouth-gag (open).

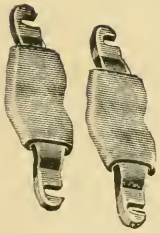

FIG. 21.—Rubber-covered plates for operations on incisor teeth.

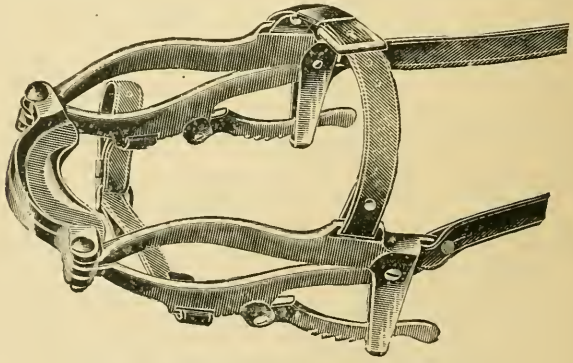

FIG. 22.—Haussmann's mouth-gag (closed).

Whether it was first invented by Haussmann or by an unknown American is open to question. In Germany it is known as Haussmann's; in England as the American mouth-gag. It possesses the important advantages of pressing only on the incisor teeth, and therefore is not liable to injure the mouth, however long its application; it leaves the cavity of the mouth entirely clear, a great point when operating on teeth; it is relaxed in a moment, and as readily extended

It can be dismounted and packed small and flat for travelling, and, being nickel-plated and of rounded form, the parts are easily disinfected. To permit of operations on incisor teeth two rubber-covered plates are supplied, which fit across the interdental space and replace the ordinary teeth plates (Fig. 21). The gag shown in Fig. 16 is for small dogs. That designed by Woolf is useful both for large and small dogs. Fig. 19 shows the older, Fig. 18 the newer improved apparatus. Fig. 23 represents the very simple and effective mouth-gag for dogs and cats introduced by Mr. Gray, M.R.C.V.S. It is very simple and cheap, is readily adjustable for large or small animals, and leaves the mouth unobstructed for operation, etc.

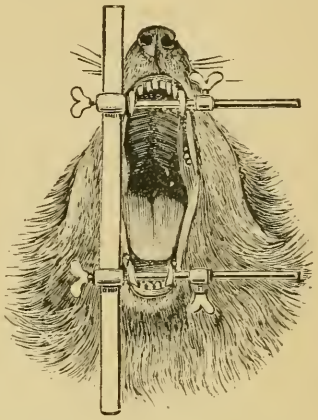

Fig. 23.—Mr. Gray's mouth-gag for dogs.

In operating on dogs precautions are required to prevent the patient biting. The best and easiest method consists simply in securing the mouth with tape. A loop of broad unbleached linen tape having been slipped over the animal's nose and lower jaw

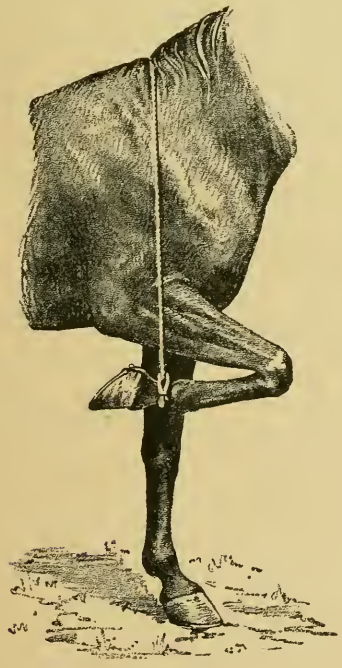

Fig. 24.—Pulling up and fixing a fore-foot for operation.

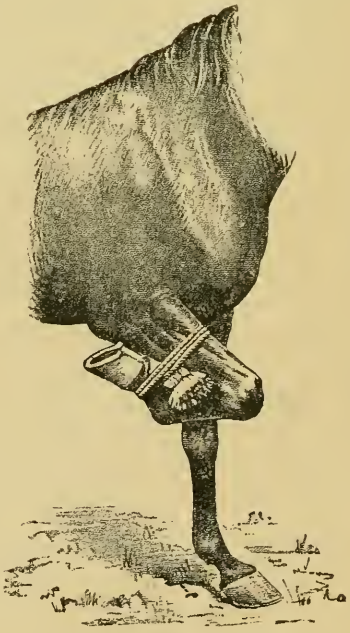

Fig. 25.—Tying up the fore-leg.

and drawn tight, the end proceeding from the right side is carried towards the left ear, that from the left side towards the right ear, and the two fastened firmly behind the head.

In some operations on horses it is sufficient if the ears are grasped by a couple of powerful assistants and the head drawn forcibly downwards. This does not completely insure the operator's safety, but it checks attempts at rearing and striking with the front feet. This method of drawing down the head is certainly better than fastening the animal to a fixed object, though in cattle the best available means often is to fix a rope around the horns and attach it to a strong ring or post.

FIG. 26.—Fastening the fore and hind pasterns together as a means of restraint.

Another means of restraint is to lift a fore or hind foot, preferably on the side on which the operator stands ; care must be taken, however, not to raise the limb so high as to give pain and cause the animal to rear. A fore-foot may also be raised and kept in position by passing a cord around the pastern and over the withers, in which position it is held by an assistant. This plan is preferable to that next shown, viz. of fixing the pastern to the forearm by means of a rope or strap. In this case a small bundle of straw is often thrust into the flexure of the knee to prevent the cord slipping off. As, however, the horse is apt to lose its balance, a serious fall sometimes results.

To prevent striking out with the fore-feet a foot may be lifted or both legs fastened together above the knees. Another plan is to pass a cord or strap several times around the forearms and fasten it to the surcingle. Some foreign operators fasten the fore-limb to the hind limb of the same side by a cord passed round the pasterns (Fig. 26). This prevents the horse striking out, but may cause a severe fall should it struggle. There are several methods of holding up a hind foot. A loop of cord may be passed round the neck and one of the free ends carried along the back as far as the root of the tail, around which a turn is taken; the rope is then passed once around the pastern of the hind foot to be held up. The horse is thus forced to bear a great part of any strain he may put on the limb. This is a simpler but not a better method than that of Hann, who carries a cord from a ring fixed to the top of the surcingle, first over the back and croup, then through a crupper and through

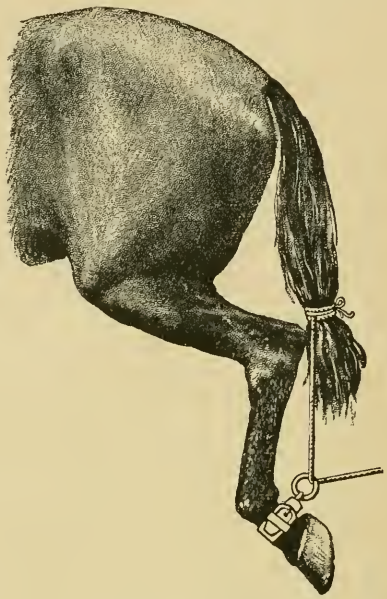

Fig. 27.—Pulling up and fixing a hind foot for operation.

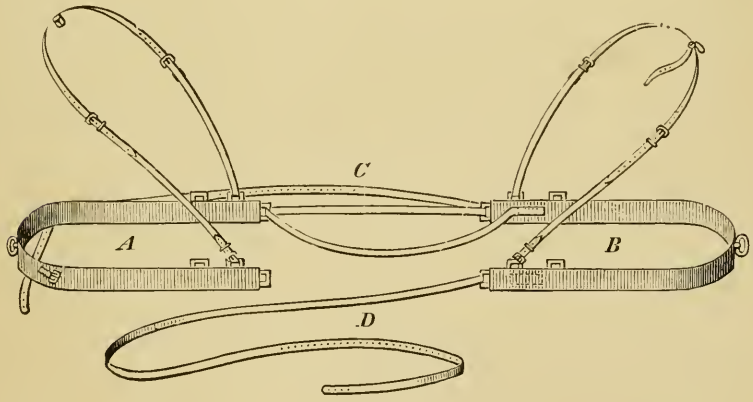

Fig. 28.—The Hippo-lasso.

the ring of a hobble attached to the pastern, returning once more through the crupper. By drawing on the free end of the cord the foot is raised

and can easily be held in position. In other cases the tail itself may be utilised, the cord being first fixed to it by a "double sheet bend"

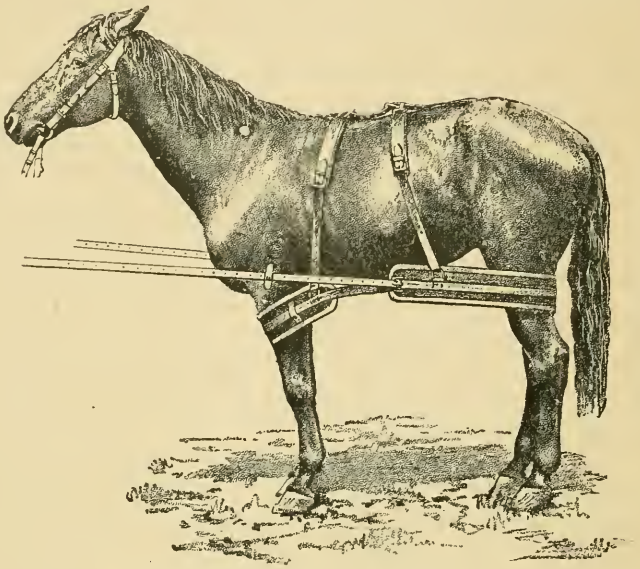

FIG. 29.—The Hippo-lasso applied.

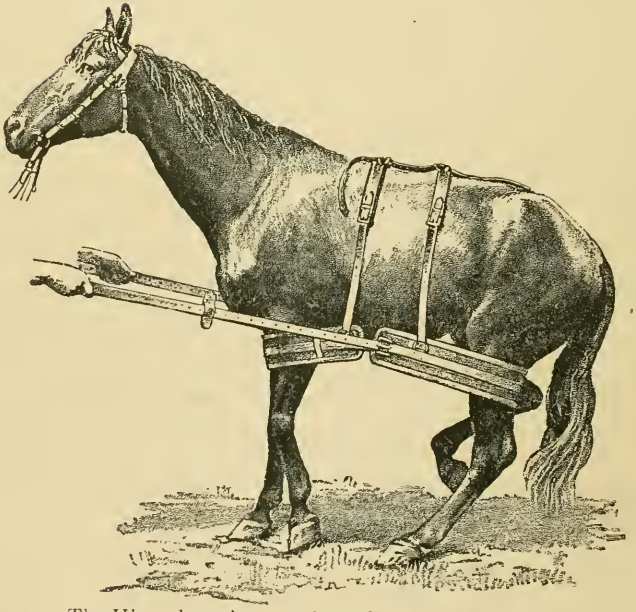

FIG. 30.—The Hippo-lasso in operation. The horse is about to lie down.

(*i. e.* a special kind of knot which will not slip), and then passed through the ring of a hobble, when by drawing on the rope the foot will be

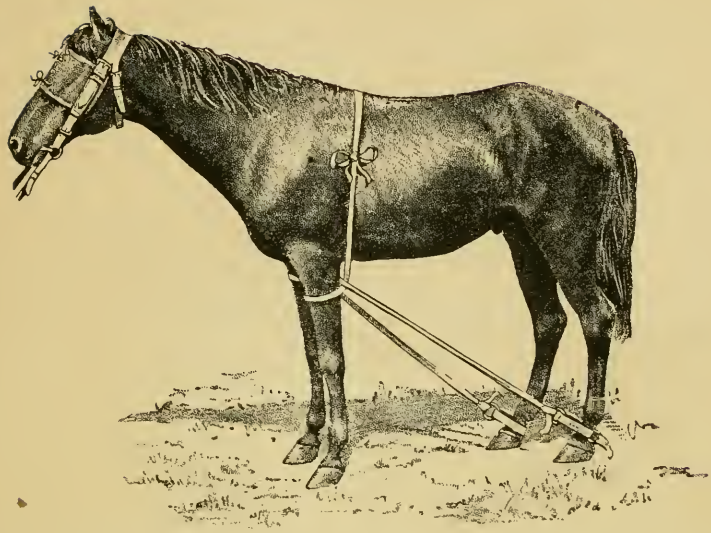

FIG. 31.—Method of securing the hind legs to prevent kicking during operation.

FIG. 32.—Fastening a bullock's hind legs preparatory to operation.

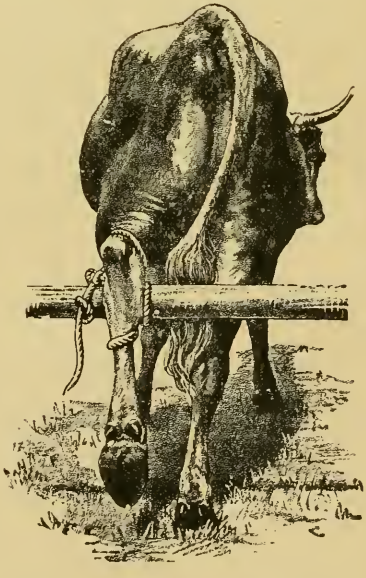

FIG. 33.—Fastening one hind leg for operation or shoeing.

raised. For dangerous horses a very useful apparatus is the hippo-lasso. It may either prepare the way for using hobbles, or may even supersede them. It consists of a front and hind portion hung by broad

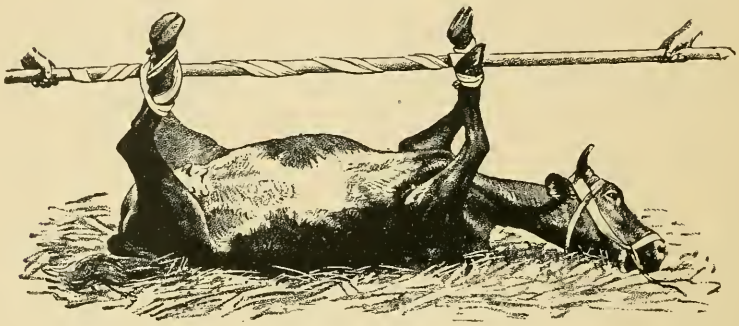

FIG. 34.—Fastening a cow for operation.

straps which pass across the back just behind the forearm and in front of the stifle-joint respectively, and held together by two

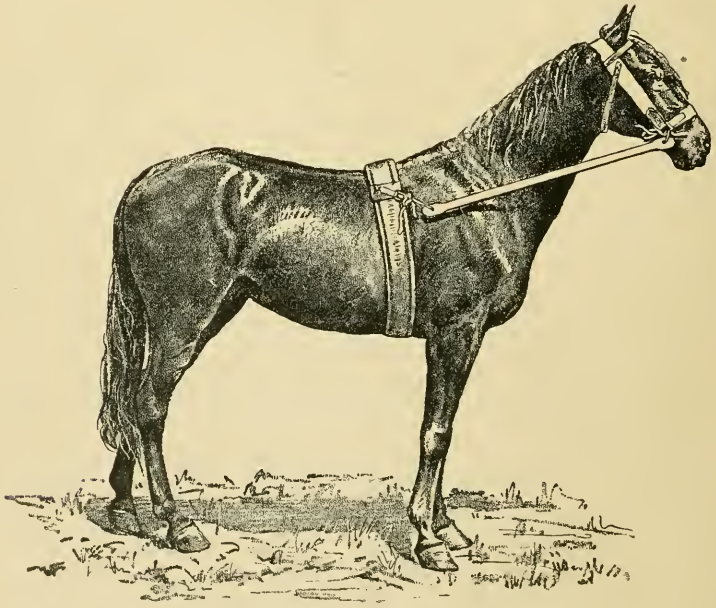

FIG. 35.—The side-stick.

other straps fastened to the front and running through rings in the back portion. By pulling on these straps the animal's fore and hind limbs are drawn together, and it is effectually prevented

from kicking either with the fore or hind limbs. Many horses when thus secured lie down without struggling. To secure the hind limbs hobbles are applied to the pasterns, from each of which a broad band of webbing is carried towards the centre of the chest from within outwards around the forearm under the preceding portion and vertically upwards over the withers. The two pieces of webbing may then be tied together.

Hess describes many very useful ways of fixing oxen, of which the best are shown in the accompanying illustrations (Figs. 32, 33, and 34).

Among other means of restraint must be numbered the side-stick (Fig. 35), a cylindrical well-rounded stick of elm or other tough wood fixed at one end to the head-collar and at the other to the

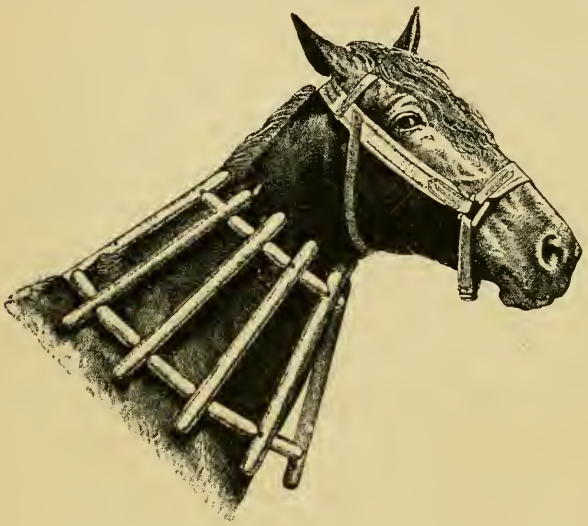

Fig. 36.—The "cradle" or "beads."

surcingle, thus limiting the movement of the head and neck. A somewhat similar result is obtained by the use of the "cradle" (Fig. 36).

"The stocks," or "trevis," is so well known as scarcely to require description here. It was used in classic Greece. It renders good service in certain operations, but is too clumsy, too little adaptable, and too large for many purposes. Farriers still use it for shoeing, and country practitioners for operations on oxen and on heavy horses.

All vaccine institutes and most foreign veterinary schools and veterinary hospitals now contain some form of table for controlling horses during operation.

The first apparatus of this kind of any practical value was Daviau's. It consisted of a large oak table about 8 × 6 feet, the upper part of the front padded with horse-hair and covered with stout leather, the lower portion and the ends perforated with holes for the passage of ropes, the whole pivoted on a horizontal axis, to which was attached a

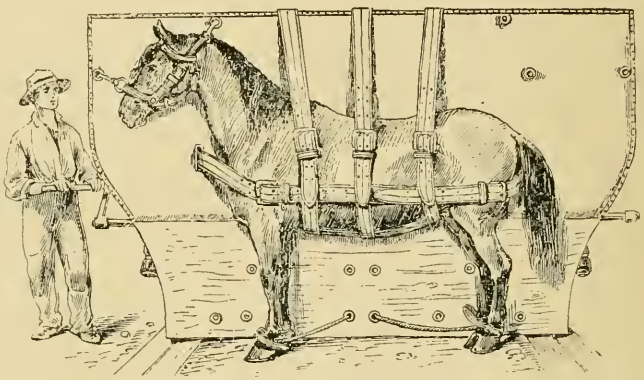

Fig. 37.—Daviau's operating table. Horse secured.

rackwork quadrant. At the back was a stout framework about 2 feet 6 inches in height with four legs, so arranged that the upright table could fold back upon it, when the whole had somewhat the appearance of an extremely massive and rather low kitchen table. In practice the horse, already provided with a powerful head-collar, was led up to the appara-

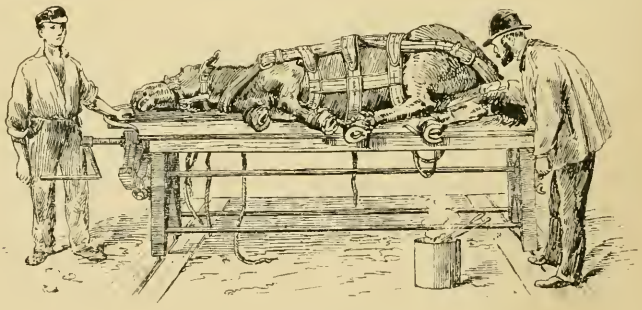

Fig. 38.—Daviau's table. Horse in position for operation.

tus, and strong ropes attached to the head-collar were passed through holes in the table and secured at the back to belaying-pins. At the same time the broad horizontal strap (attached at each end to the table) was brought round the chest and flank, and fastened by drawing the buckles tight. The vertical straps were secured, the hobbles

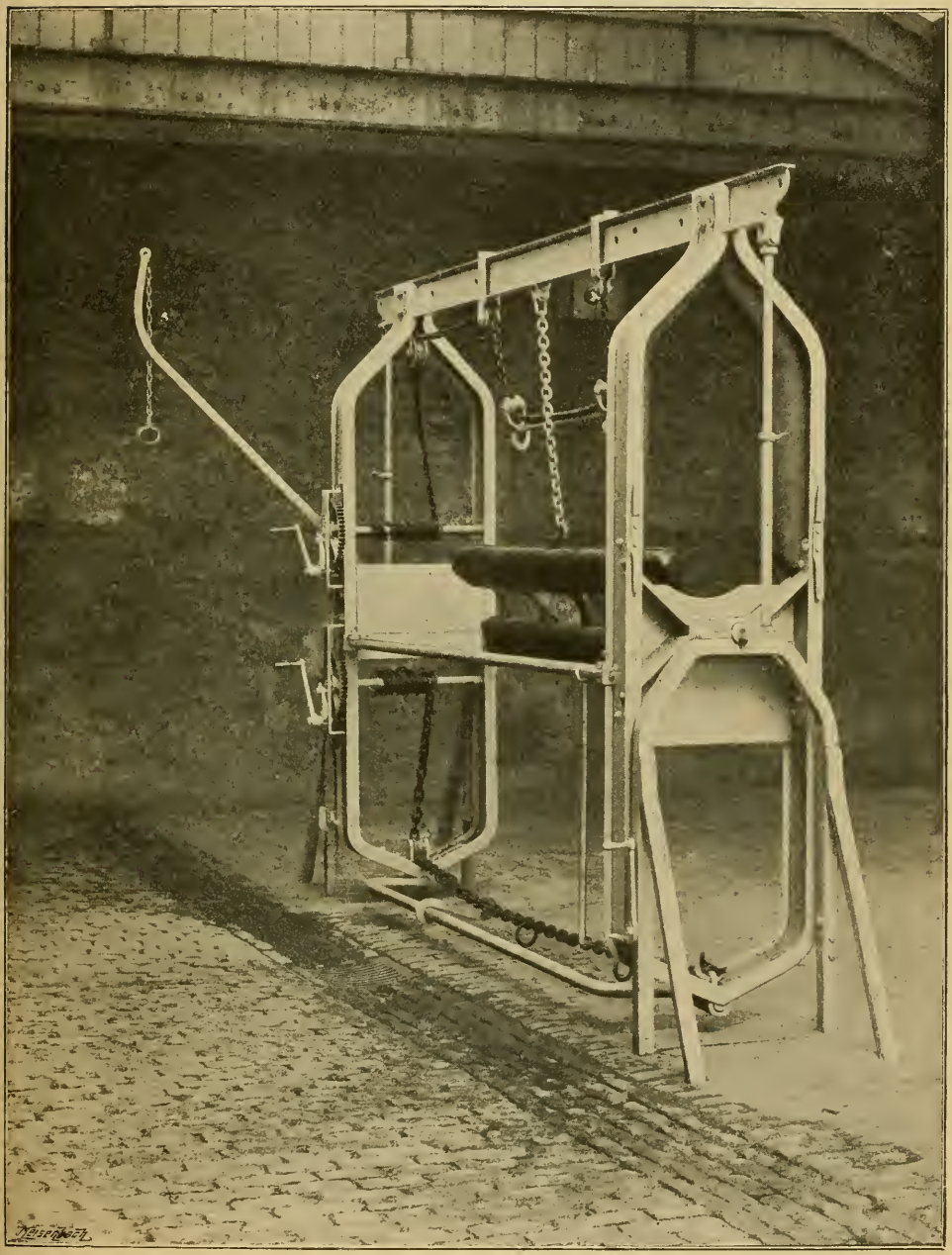

FIG. 39.—Operating table used by Mr. Dollar. The improved Vinsot model.

adjusted on the feet, and the ropes controlling them tightened and fastened to belaying-pins behind the table. Thus secured, the horse and table were turned through the arc of a circle by working the crank handle seen on the left side.

For minor operations this table served a very useful purpose, but a patent defect was the inaccessibility of one side of the horse, and the need, when both sides had to be operated on, of releasing, turning round, and refastening the animal.

The most practical apparatus hitherto introduced is probably that shown in Figs. 39 to 42. It was originally invented about 1890 by M. Vinsot, a former student of Alfort, with whom the writer has for some years been associated. As now modified this table has proved very successful, especially in the East, where Mr. Dollar has sent a considerable number for the use of hospitals and bacteriological institutes.

The main portion of the apparatus is seen roughly to consist of two approximately rectangular end pieces, connected at the top by a strong steel girder, and at the bottom by a strong iron rod of circular section. These rectangular frames are further connected at 2 feet 6 inches from the ground by two movable rods, adapted to swing open, and the whole framework is supported and pivoted on two powerful axes, placed as nearly as possible on a level with the general centre of gravity of the whole machine. A double cushion, intended to support the horse when lying, is capable of attachment to either of these side rods.

The purpose of the various rachet wheels and chains will be better understood by reference to the figures showing the horse in position for turning over. His head, secured by a strong head-collar and side-ropes, rests within the padded upper portions of the front frame. Under his body passes a strong "bed-piece" reinforced with leather straps, the extremities of which carry iron eyes for the reception of a chain, by tightening which he is lifted almost off his feet just before turning over. In front this "bed-piece" is secured in position by a strap passing round the chest, and behind by a crupper attached to the back chain. The chain is wound on a spindle, turned, through the medium of gearing, by the crank handle shown. The horse's feet are fixed by hobbles to a strong chain running along the whole length of the bottom of the apparatus, and tightened by turning the lower of the two crank handles seen to the right.

To support the revolving part, which weighs 7 cwt. and is capable of accommodating horses of any size, two strong iron standards 4 feet 6 inches high, and provided with stays of 2-inch iron, are sunk in the earth, where they are surrounded by masses of concrete weighing five

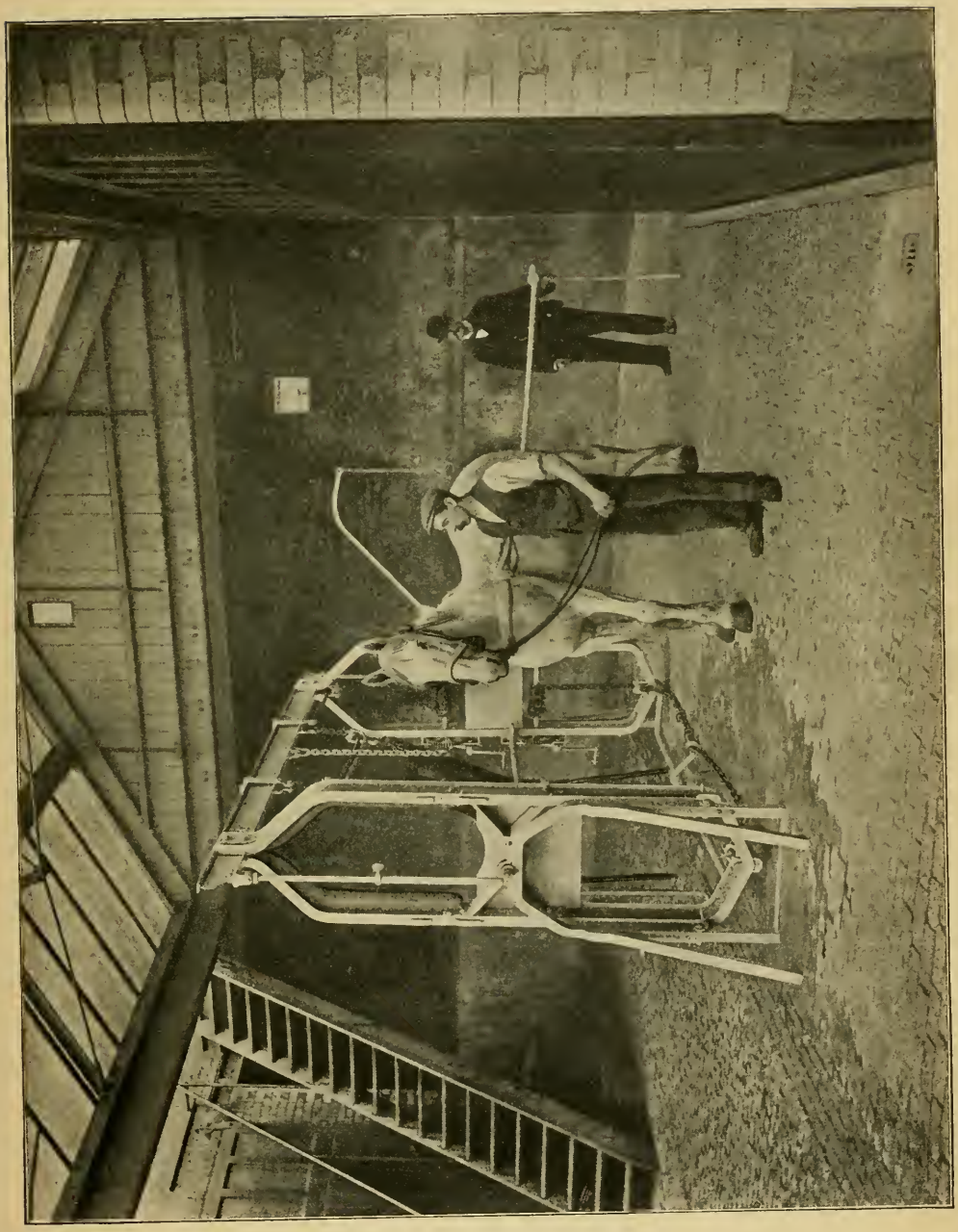

FIG. 40.—The horse entering the operating table.

tons. This provides a practically immovable base, on which any accidental shocks can have no effect. Each standard carries at its upper part a carefully turned bearing to receive the axes of the revolving part.

The forward end piece is padded inside to prevent the horse accidentally injuring his head, and is perforated throughout its upper part with one-inch holes to permit the head-collar ropes being passed through and fastened to spring belaying-pins seen projecting in front.

The rods suspended from either end of the upper girder are telescopic, and automatically stop the machine when tilted at whatever point desired by the operator.

Lastly, the revolving portion of the apparatus in which the animal is fixed is secured against premature movement by four "safety chocks" or catches secured to the standard, and locking with the end frames. The lever arm shown at the back and on the left side of Figs. 39 and 41 can be affixed to either end of the machine, and gives the operator the necessary purchase for moving the animal when in position.

The disposition of weight has been so carefully planned that when ready for rotation horse and machine form a mass whose common centre of gravity is within an inch or two of the horizontal axis around which the whole moves. Very little exertion is therefore required in handling even a heavy horse, and no undue strain is thrown on the machine, whatever the point at which it may be brought to rest.

In use, the horse is first provided with a strong head collar carrying two stout lines, and the "bed-piece" is strapped tightly round his body like a horse-rug. One of the side rods is swung open, giving admission to the machine, and the horse is walked forward until his head comes within the front frame. At the same moment the assistant follows up with the side bar, and, as the horse enters, drops the bar in place, where it locks of itself. The groom passes the head collar lines through holes in the front frame, and drawing them tight winds them in a figure of 8 round the spring belaying-pins, while the "bed-piece" is hooked on to the hanging "compensation bar." If a comparatively simple operation is to be performed nothing further is needed. A hind foot may be drawn up and fixed for examination or dressing, and the horse be set at liberty again in less than a couple of minutes.

If, however, any serious operation is required four hobbles are affixed to the feet, the winch handles are turned (both together) until the horse's feet begin to leave the ground, when the safety chocks are cast off, permitting the apparatus to revolve, and depositing the horse

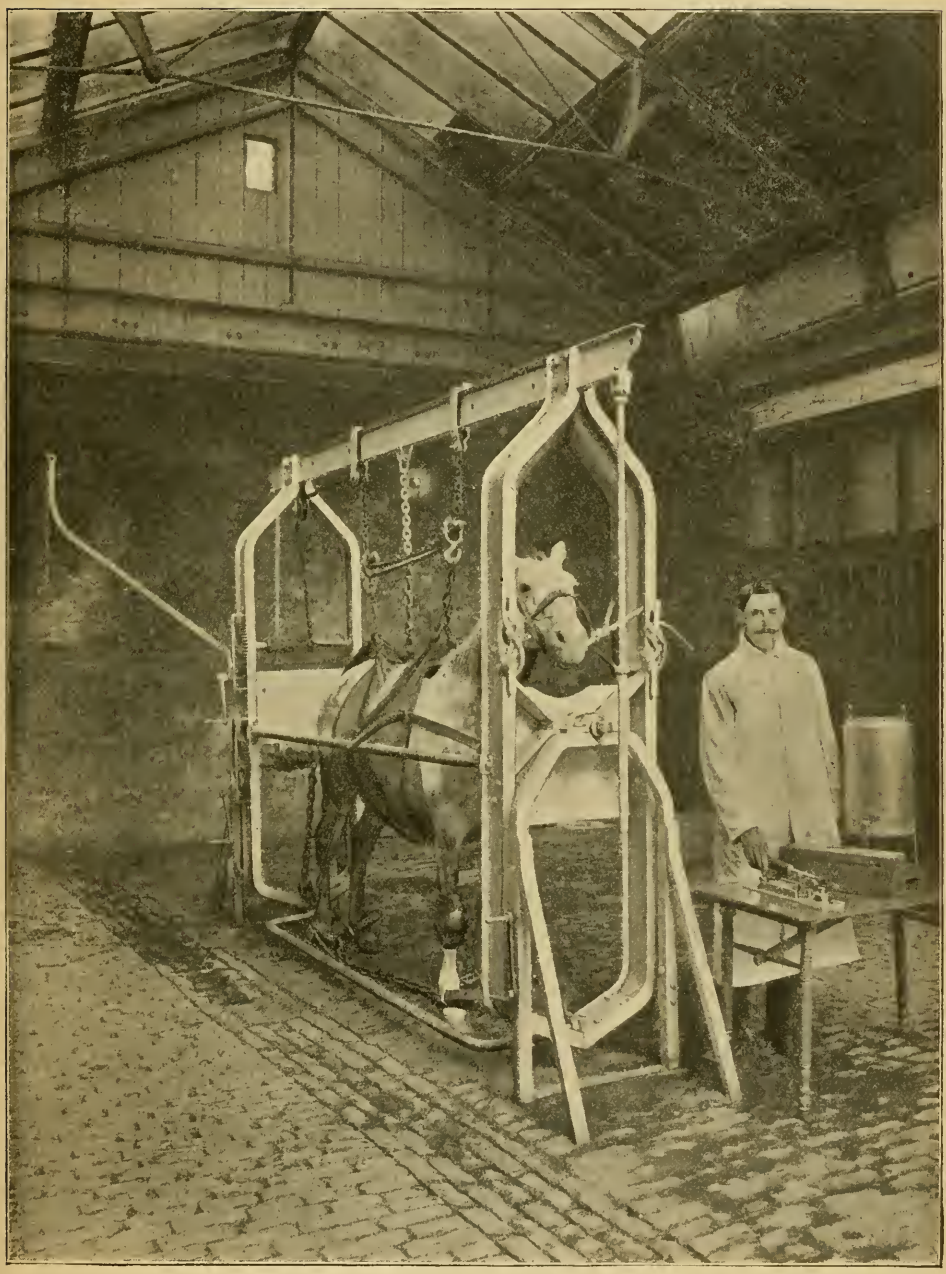

FIG 41.—The horse secured for operation.

without shock or pain in a horizontal position. The animal may be placed at any degree of inclination to the horizontal, and its position on the table is extremely safe. Broken back has never occurred within the writer's experience.

Methods of Casting.—A permanent bed is usually prepared with six to eight inches of dry spent tan bark, covered with a thick layer of short cut straw. Many practitioners still prefer the straw bed to mattresses, because it is softer and because it can be removed, and fresh straw supplied after each operation, whilst the mattress must be thoroughly cleansed and disinfected. It has also the advantage of being cheap, as clean straw is readily obtainable and may afterwards be used for bedding, whilst it is a difficult matter for veterinary surgeons in country practice to convey a mattress from place to place. Nevertheless, straw makes a very bad bed for operations requiring careful antiseptic precautions, and wherever possible should be replaced by a mattress covered with tarpaulin, or by a proper operating table, though some of the disadvantages of the straw bed may be overcome by covering it with a large tarpaulin before casting the horse. Even so high an authority, however, as Professor Bayer still adheres to the straw bed, preferring it partly because he has to teach students who, in practice, would be unable to afford an operating table, and partly because of the success attained in his own clinique. In support of his recommendation he adduces a long series of cases in which the wounds left by removal of shoulder abscesses, necrotic lateral cartilages, etc., healed by primary intention after suturing.

To prevent internal injuries, like rupture of abdominal viscera, the animal should fast or only receive light food for several hours before operation, though, as already mentioned, this precaution is not absolutely indispensable. Needless to say cases calling for puncture of the bowel or bladder must not be cast. Should it be absolutely impossible to perform the operation in the standing posture the operator should wait until the horse lies down, as usually occurs with moderate frequency in these cases on account of the animal's pain. On the other hand, in cases of hernia where the bowel is distended as a result of strangulation, the horse should be cast to prevent him throwing himself down in the violence of his pain, but the greatest precautions should then be exercised. One of the simplest methods of casting is that shown in Fig. 43. It is especially useful for young animals or those difficult to approach, in which ordinary hobbles cannot be used. It is also useful where the hind legs have to be drawn downwards on either side of the body for operations in the dorsal position, inasmuch

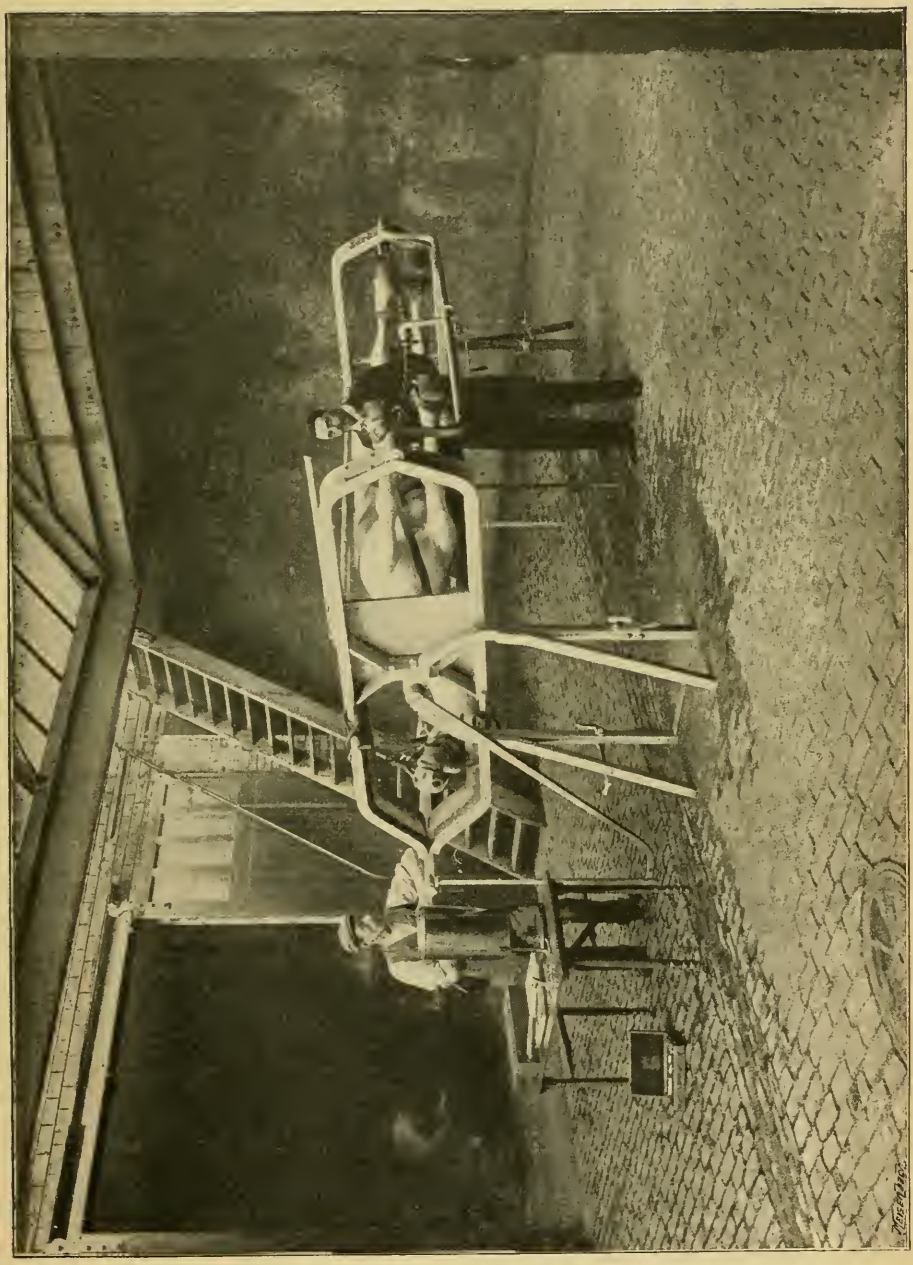

FIG. 42.—In position for operating; patient turned to the left. Showing the free accessibility to all parts.

as the application and removal of hobbles are thereby rendered unnecessary. In case of need a cart rope may be used. A strong bridle or halter and a surcingle carrying a ring and rope having been applied, a man is placed at the horse's head, and another, who holds the surcingle rope, is given a position on the side towards which the animal is required to fall. If possible the fore-foot furthest from the bed is then lifted. On the end of the long rope is tied a fixed noose, which is placed round the animal's neck like a collar; the free end is then passed around both hind legs, brought forward, again passed through the loop on the animal's shoulders, and given to the men charged with casting the

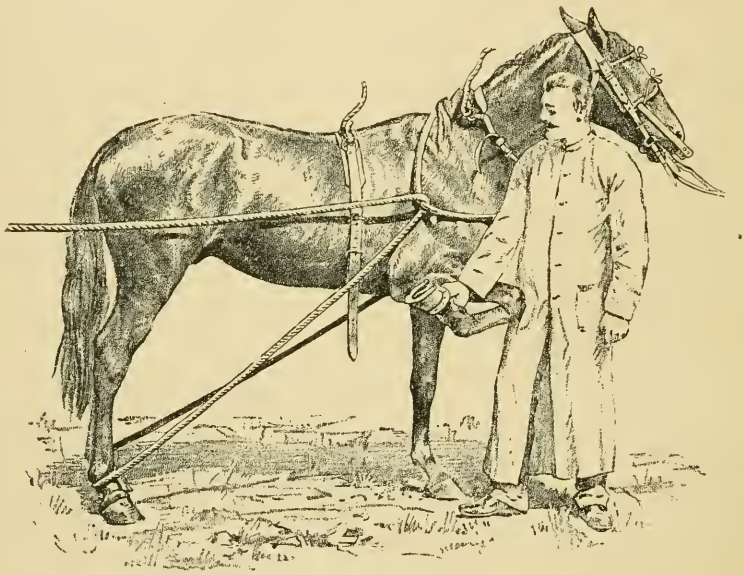

FIG. 43.—Casting with the cart rope. Attention is directed to the fact that both hind pasterns are embraced in the one loop of rope.

animal. On the word being given, these men should rapidly draw the rope backwards towards the side to which the horse is intended to fall. The rope thus catches in the heels just below the pastern and the animal is thrown on its haunches. At the same moment the man holding the cord attached to the surcingle pulls in a similar direction. The attendant in charge of the head assists the movement, and the horse falls to the ground. This method causes the least concussion, and can even be safely used for pregnant mares. The only objection is that if the ropes be new, or the first attempt fail, the animal's heels may be injured, but this can be avoided by previously applying bandages or using cotton ropes. Where many horses are cast by this method the

loop of rope passed round the neck may advantageously be replaced by a strong leather strap provided with iron eyelets, through which the rope is returned, these eyelets diminishing friction and permitting the rope to run more freely.

A commoner method of procedure is to form in the centre of a long rope, a fixed loop sufficiently large to pass round the animal's

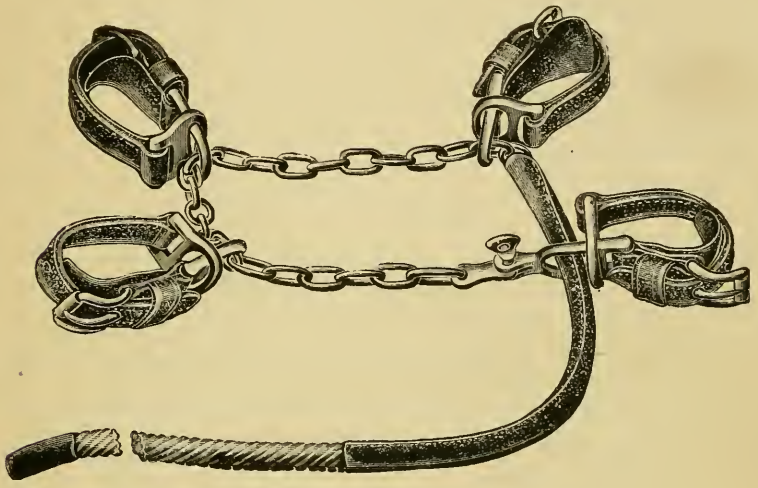

Fig. 44.—The hobbles.

neck and rest on its shoulders. The knot lies in front of the chest, and the free ends of the rope are passed from within outwards round the hind legs above the hocks, and back again through the neck loop. They are then held on each side by one or two men, according to the animal's size and weight. When all is ready one of the fore-feet is lifted, the

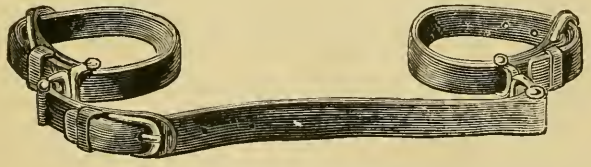

Fig. 45.—Cross-hobbles, or thigh and forearm straps.

loops of rope are slipped from above the hocks downwards into the hollows of the heels, and the men pull steadily on the free ends of the rope, causing the animal to subside on its hocks, whence it usually falls gently on to its quarters. It is best if one group of men pulls outwards at right angles to the shoulder and the other somewhat backwards. Immediately the animal is on the ground it is pushed on to its back,

the ropes are pulled tight, drawing down the hind legs level with the abdomen, and secured to the pastern with one or two half-hitches. The fore legs are firmly grasped, brought alongside the hind, and secured to them by a couple of half-hitches passed round the pasterns. This method has the advantage of requiring no re-arrangement of the ropes to draw down the hind legs and so expose the field of operation for castration, though, as the hind limbs are at first comparatively free, the animal can plant them wide apart, and the force required for casting it is somewhat greater than in the method previously mentioned. It is usually employed when castrating colts. Some operators use a stout leather strap collar with iron eyes for the passage of the ropes, instead

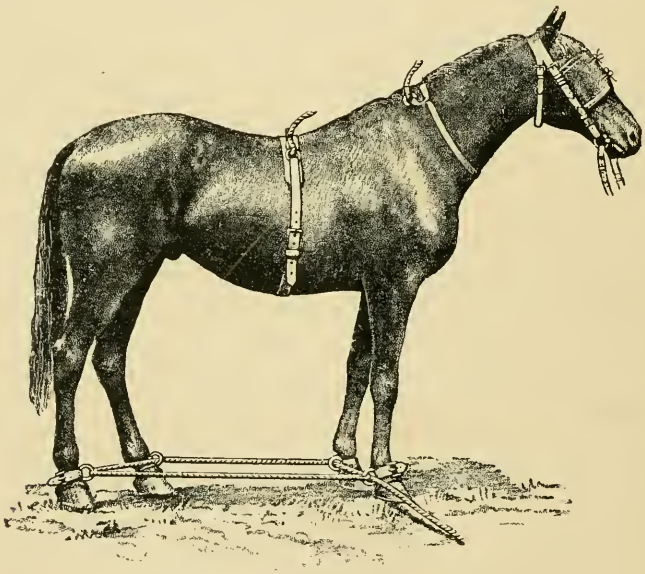

Fig. 46.—The hobbles applied.

of merely passing them through the improvised rope loop. When the animal is very active it is well to affix a roller or surcingle to which the collar or neck loop can be tied ; otherwise the latter may slip off.

To work the above methods successfully requires thorough discipline of and co-operation between the various assistants. Failure on the part of anyone may entail serious accident or failure of the whole operation. The method of casting, however, most frequently employed is that illustrated in Figs. 46 and 47, which show the application of leather hobbles. The hobble usually applied to the near fore-limb is called the master-hobble, and carries a special key by means of which the chain or rope is attached. Traction on the rope draws the feet together, the

horse begins to lose its balance, and at the critical moment the rope attached to the surcingle is pulled, one or more assistants helping if necessary by pulling on the tail. The hobble rope should be pulled in a backward direction, as this to some extent neutralises the strain on the assistants, and prevents the animal's legs being pulled directly from under it and so bringing it violently to the ground. The assistants should be well drilled beforehand, and the operation carried out as quietly as possible. In Fig. 47 the horse is provided with Bernadot and Butel's apparatus for preventing broken back. The difference between this and the Stuttgart method is clear on reference to Fig. 48.

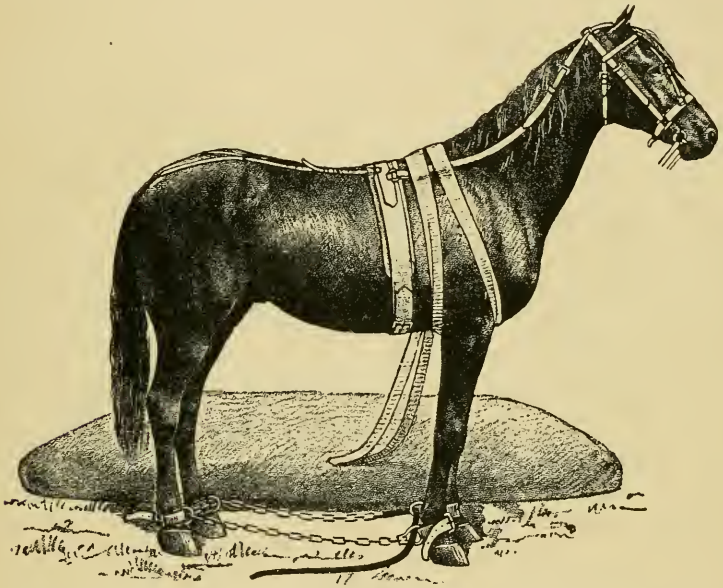

FIG. 47.—The hobbles applied together with Bernadot and Butel's apparatus for the prevention of broken back. The strip of webbing passed round the off forearm is intended to afford a purchase when pulling the horse over in the act of casting.

The advantage of the Stuttgart arrangement is that the ropes run more easily, as each only passes through one link ; and as the direction of pull is opposite for the two groups of men, there is no tendency to bring the horse down violently on its side.

The horse having been brought to the ground is kept down by the man at the bridle firmly pressing on the head, and other persons sitting on the shoulder and haunch respectively. The four feet having been tightly drawn together are fixed by passing a key (Fig. 49) through a link of the chain. The spring key shown is perhaps less convenient than the D-shaped spring key, though there is no essential difference

between the two. As a makeshift the chain may be fixed by forming a slip-knot as close as possible to the hobbles and passing a bundle of straw through the loop. The person at the horse's head must take care that the animal does not succeed in bending its head towards its chest and arching its neck, because this attitude, which facilitates contraction of the great muscles of the back and quarters, is often responsible for fractures of the vertebræ.

To retain the head extended Bernadot and Butel invented an apparatus consisting of a strong head-collar, from which powerful straps run backwards above the neck, and are attached on either side to a ring in the surcingle. The surcingle is prevented from slipping forward

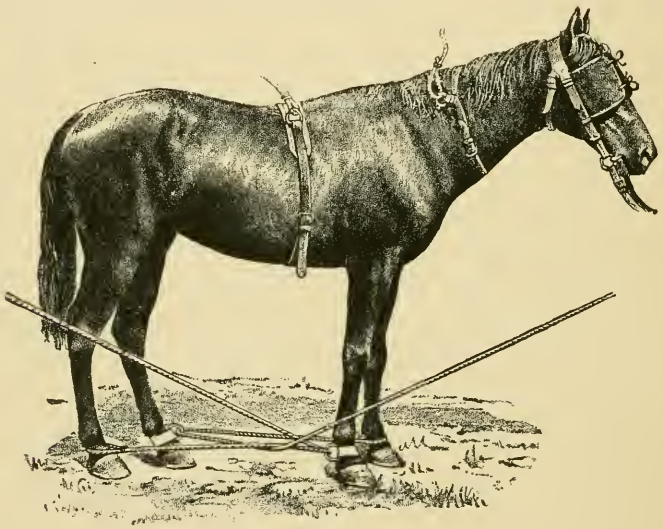

Fig. 48.—Method of casting as adopted at the Stuttgart Veterinary School.

by the use of a crupper. The apparatus is applied loosely before casting, and the straps tightened after the animal is on the ground.

The releasing of an animal depends on the method employed for casting. Most hobbles are arranged so that all four feet are immediately loosened by withdrawing the screw-key of the master hobble, but where no such arrangement exists the fore and hind feet of the lower side should first be set free, and then those of the upper side. The assistants sitting on the shoulder and haunch should not move until the man in charge of the bridle is quite prepared for the animal's rising, and the word of command has been given. Should the fore-quarters be on a lower level than the hind, or the back lower than the feet, the horse may have difficulty in rising. In such case the

fore-feet must be drawn out in front of the horse, and the animal assisted by men placed at its quarter, shoulder, and tail.

The animal having been cast, it may become necessary to release and again secure a limb, according to the operation to be performed. For this purpose the best material is webbing; cords are apt to cut. The webbing having been doubled, a running loop is formed in it and slipped over the horse's fetlock; the two ends of webbing are then passed in opposite directions and held fast by assistants. The men sitting on the shoulder and haunch can also check the animal's movements by utilising their weight and by grasping the limbs with their hands. A better method, however, is to pass a loop of webbing around the two forearms or cannon bones. Movement in the fore and hind limbs

Fig. 49.—The hobble-chain key.

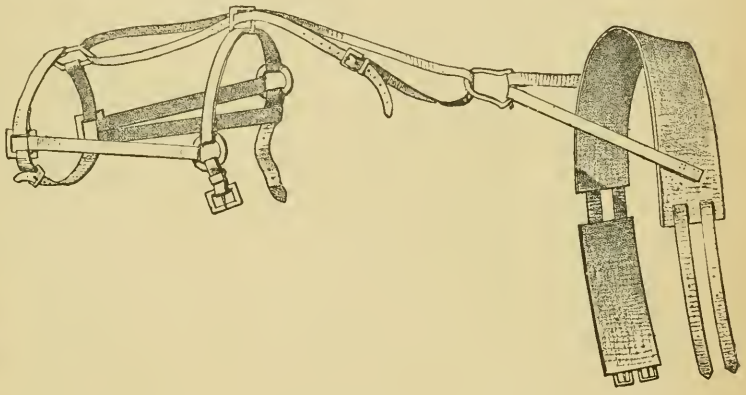

Fig. 50.—Bernadot and Butel's apparatus for the prevention of broken back.

which are for the moment uppermost, can also be checked by passing a large strap or piece of webbing over the hock-joint and then around the forearm, or by the application of the cross-hobbles shown in Fig. 45.

For operations on the fore-limb, like extirpation of the lateral cartilage, neurectomy, etc., Möller's method of fixing the limb to a long plank is very useful. The plank should be well padded, and provided with a long curved iron handle. It is less useful for hind limbs, inasmuch as the limb can only be fixed at two points, viz. at the fetlock and above or below the hock.

To draw a hind foot closer to a fore-foot, as in preparing for castration in the side position, a running loop is formed at the end of a piece of webbing and slipped over the fetlock of the hind foot; the webbing is then carried over the withers, beneath the neck, over the front of the chest, around the forearm, and thence backwards, passing from

below upwards around the Achilles tendon and once again forwards. By pulling on the free end an assistant can then bring the limb into

FIG. 51.—Horse cast and secured. The near forearm and near thigh are fastened together by broad strips of webbing (the cross hobbles may be used instead), and the off fore-leg is fastened to the plank ready for operation on the foot (Möller's method).

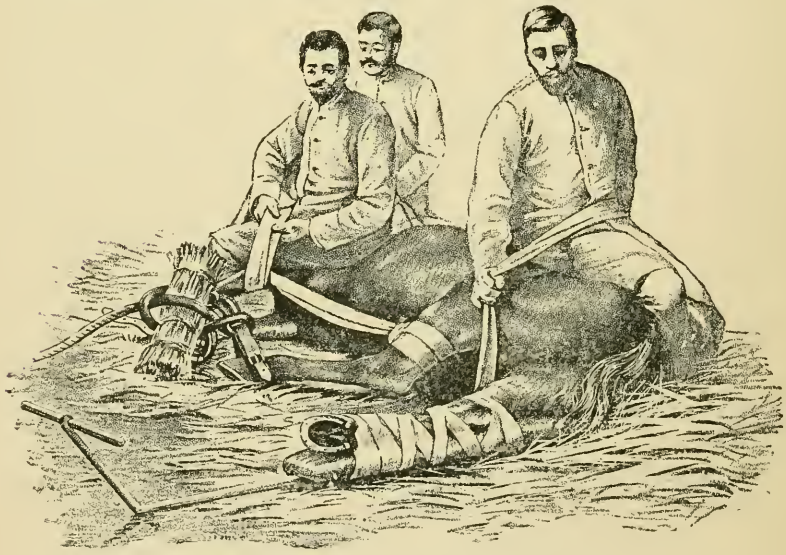

FIG. 52.—This figure shows method of securing a hind limb to the plank for operation. Compare with foregoing figure.

the position shown in Figs. 53, 54. Another way of attaining the same object (the Berlin method) is shown in Fig. 55.

The method of fixing the upper hind to the upper fore-limb is shown in Fig. 56; that of fixing the lower hind to the upper fore in Fig. 57.

For operations in the dorsal position the fore and hind limbs of each side must first be firmly fixed together. Either rope or webbing can

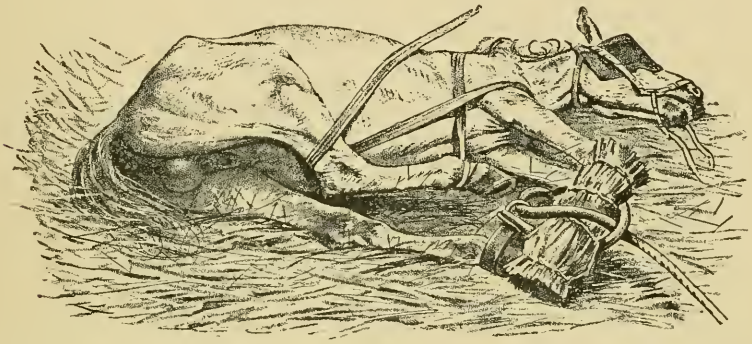

Fig. 53.—The horse cast and tied. The off hind leg being drawn forward ready for castration in the side position.

be used, the fastening being accomplished by means of a running noose attached to the fetlock of the hind foot, and by applying one or two half hitches to that of the fore-foot, drawing the rope tightly after each half hitch is in position. When the horse is rolled on to its back,

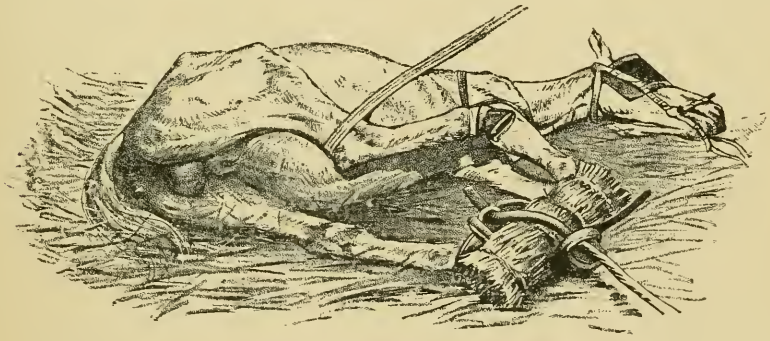

Fig. 54.—The horse secured ready for castration in the side position.

care must be taken that the neck and head are kept straight and the head is not allowed to be bent towards the chest. A piece of webbing can then be fastened to one of the hind limbs just above the fetlock, passed under the animal's back, and then from within outwards over the fetlock of the opposite side. By drawing this tight the hind legs are pressed down close to the sides and secured. In Vienna a special

FIG. 55.—Another method of preparing the horse for castration or similar operation in the side position.

FIG. 56.—Fastening a hind to a fore-limb preparatory to neurectomy, firing, etc.

piece of apparatus is used for this purpose. The method is as follows:—One or two assistants grasp the horse's tail and lift the hind quarters far enough from the ground to allow a leather band, about eight to ten inches wide, to be slipped under. The ends of the band carry broad iron rings. Through these and around the cannon bones of the hind limbs broad pieces of webbing are passed, securing the hind limbs in place. The cannon bones must be pressed downwards into a horizontal position, whilst the parts are being fixed (Fig. 59). (NOTE.—In this figure the assistants on the left side of the animal are not represented, and the horse is purposely shown lying a little obliquely, in order that the mode of fixation may be clearer). The operation finished,

FIG. 57.—Fastening the lower hind to the upper fore-limb preparatory to neurectomy, firing, etc. This figure also shows the "leg twitch" applied.

the broad leather strap passed beneath the animal is first removed; the horse is then laid on his side, the limbs are released, the upper being last of all freed from hobbles. Fig. 60 shows another method of fixing a horse for operation as employed in the Berlin veterinary school.

The Russian method of casting (Figs. 61—63) permits of a man throwing a horse single-handed. In books the position of the operator's hands is usually incorrect. With small horses the method succeeds very well, though requiring some courage. The operator stands close to that side of the horse on which it is intended to fall,

and at the first trial this seems dangerous. Professor Bayer, in referring to the operation, states that on one occasion he actually fell under the horse. He had attempted to cast a rather large horse, and had nearly succeeded; the animal, however, tried to regain its equi-

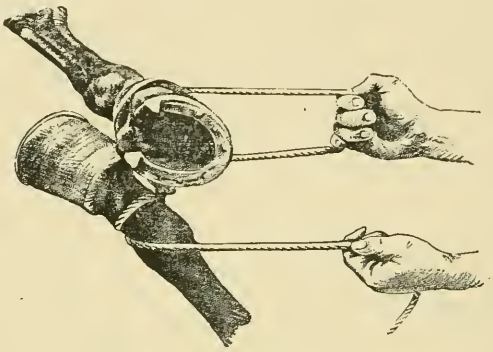

FIG. 58.—The horse cast. Mode of fixing the fore and hind limbs together when preparing for castration in the dorsal position.

librium by a slight spring, and trod on Bayer's foot, preventing his getting clear.

A long rope carrying a ring at one end is used. Supposing a horse is

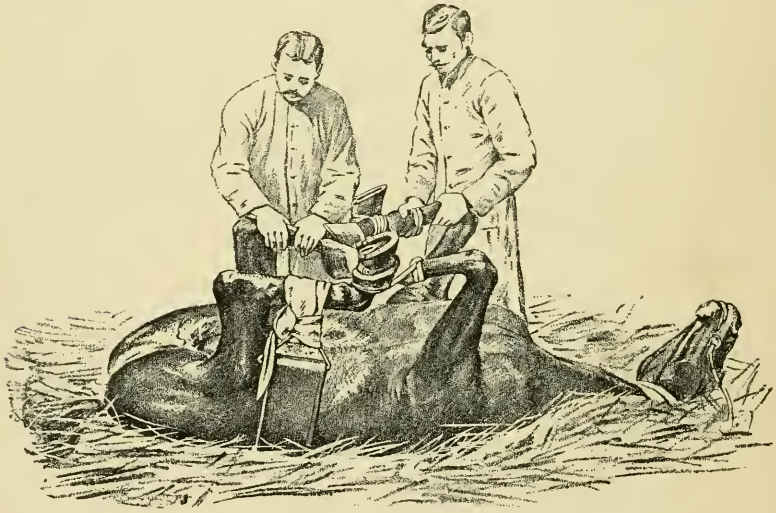

FIG. 59.—Preparing for castration in the dorsal position. The back strap applied. (Vienna method.)

intended to fall on its left side, a loop is formed in the rope and passed around the neck, the ring lying near the right elbow. The free end of the rope is then passed around the left hind foot, again through the

ring, and is held in the operator's right hand. The operator stands on the horse's left side looking forwards, his right elbow supported on the horse's loins, and the bridle reins grasped in the left hand. By lifting the left hind foot under the belly and somewhat towards the right side, drawing the head to the right by means of the bit, and simultaneously pressing with the elbow on the loins, the horse is caused first to recoil on its haunches, and then to lie down on its left side. The operator has only to hold the cord and bridle tight to prevent the animal rising.

Cattle can be cast like horses with ordinary hobbles, the straps being placed above the fetlocks, or by the methods shown in Figs. 64 65

Fig. 60.—Berlin method of fixing the horse in dorsal position for operation.

and Fig. 43. Another method is illustrated in Figs. 64, 65. A rope having been fastened to the horns, is passed around the neck, chest, and abdomen as shown. The animal is held by an ox-lead, and two men pull on the end of the rope, when the animal usually lies down on its side without struggling and with its feet stretched out.

For castration the sheep is placed on its hind quarters in a sitting position, the abdomen being turned towards the operator. An assistant grasps the body between his legs and holds a limb with each hand. For carriage the fore and hind legs of each side are first tied together, the two sides being afterwards connected by a few turns of the rope.

The pig is best seized just above the hock, and can then be cast by an assistant who grasps the ears. In the large stockyards, however, men become very expert in casting the pig single-handed, by slipping

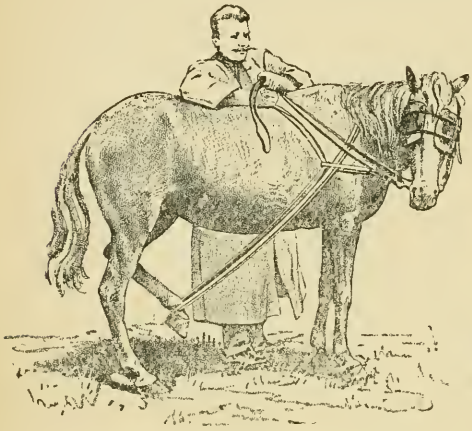

FIG. 61.—The Russian method of casting, single-handed; first position.

FIG. 62.—The Russian method of casting, single-handed; second position.

FIG. 63.—The Russian method of casting; the horse down.

a short staff between the hind legs as the animal runs. To examine the mouth, a short stick is thrust between the jaws at the moment when the animal squeals, and can then be used as a lever to keep them

open. A kind of twitch applied to the jaws is also used. Another method is as follows:—Two men grasp the pig by the ears; when the animal cries, a slip-knot, formed on the end of a stout cord, is passed into the mouth and fastened to the upper jaw as near as possible to the commissure, behind the tusks. The cord is then fastened

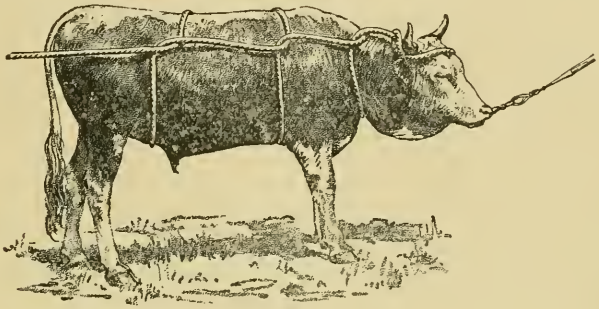

FIG. 64.—Casting an ox; first position.

to any high point or to a ring, and the head drawn into a position of forced extension. The animal cannot possibly escape.

The dog is either muzzled or the jaws fastened together by a piece of tape passed around them and tied behind the ears. It is then easily handled and secured on the operating table. Several operating tables have been invented for dogs. In Professor Bayer's clinique the table is a shallow glass trough about 3 feet 6 inches long and 15 inches across, with an aperture for drainage, and suitable connections at the lowest

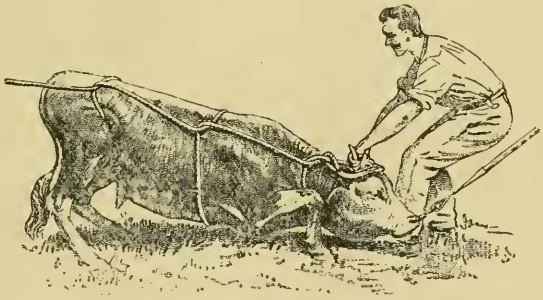

FIG. 65.—Casting an ox; second position.

point. This is surrounded by a detachable metal frame, the lower surface of which carries a series of hooks at one-inch intervals for fastening the cords by which the animal is secured. In the very excellent clinique for small animals at Berlin, presided over, at the date of the writer's period of study, by Prof. Fröhner, the table is of similar

form, but is constructed throughout of metal. Both tables, in fact, are close imitations of those used in human surgery.

In this country, Professor Hobday has suggested a cheap and useful table of wood, the upper surface perfectly flat and displaying numerous incisions for receiving the small keys by which the hobbles are secured to the table. This table, owing to the numerous perforations, is, of course, less readily rendered aseptic than a metal or glass table, though in actual practice the point is not of prime importance. Professor Macqueen has recently brought before the profession an excellent table, also of wood, designed by Claude Bernard, consisting of four parallel leaves connected by hinges. The two outer leaves may be

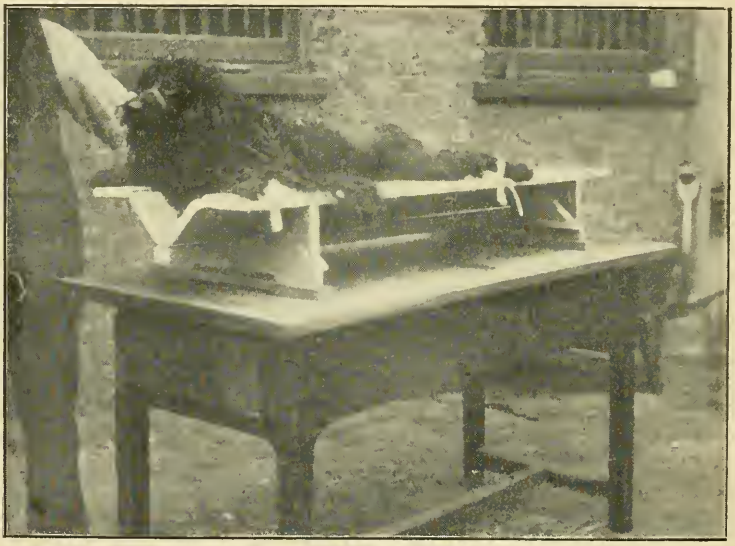

FIG. 66.—Professor Macqueen's operating table for the dog (Claude Bernard's design).

inclined at any angle towards one another, forming a trough to receive the animal's body. Owing to its great simplicity and absence of depressions likely to retain dirt, etc., this table is cheap, and responds to most of the requirements of veterinary surgery, while it is readily adaptable to animals of varying size, and when folded is quite portable. The writer is indebted to the courtesy of the proprietor of the 'Veterinary Record' for the illustration of this latter table.

A special instrument is used in France for securing dogs suspected of rabies. It has a long handle, and carries at the end a spring collar which, when pressed on the dog's neck, opens and holds him securely.

For castration and other operations on the cat, the skin at the back of the neck is grasped with one hand, that over the lumbar region with the other, and the subject firmly pressed down on a table. Another method is for the assistant to grasp the hind limbs on either side between the second and third fingers, the fore-limbs between the index and second fingers, and the skin on either side of the head with the index finger and thumb. Thus held the animal is quite powerless. Troublesome patients may be wrapped in a thick cloth to prevent scratching and biting. It is sometimes recommended to thrust the animal into a narrow sack or into a boot. These methods, of course, are primitive and only suitable for trifling operations. For more complicated operations one or other of the above-mentioned tables may be used.

Complications.—Application of the above-described methods of restraint are not infrequently followed by injuries or complications. The animal begins to resist immediately the hobbles are applied. A horse often struggles, kicks, or moves away on finding the free use of its limbs checked, and may fall awkwardly, breaking the jaw, neck, shoulder, or a limb bone, according to the incidence of the shock. Fracture of the pelvis or of ribs is not infrequent when horses are cast suddenly and violently. Even when secured, the muscular efforts consequent on struggling may cause fractures of vertebræ, of the pelvis, of the cannon bone, os calcis, etc., rupture of abdominal viscera, of large vessels, important muscles, or of tendons, not to mention the skin wounds and contusions which almost always occur. Pressure on nerves such as the facial or radial, due to lying long in one position, may be followed by cramp or paralysis.

CHAPTER III.

ANÆSTHESIA.

Anæsthesia may be divided according to its nature and extent into general and local. We shall consider these in order.

The first operation under ether was performed on the 14th October, 1846, by Warren, in the Faculty of Medicine at Boston. Boots and Lister first employed ether in England. During 1847 several veterinary surgeons published experiments showing the advantages of its use in operations on the horse.

Notwithstanding certain drawbacks ether was at first exclusively used, but on the 10th November, 1847, Simpson drew attention to the anæsthetic qualities of chloroform, which he declared superior to its predecessor. Chloroform soon displaced ether, maintaining its supremacy in man until a relatively recent date. In animals, save perhaps the dog and cat, it is still the anæsthetic *par excellence*.

Other substances have been introduced during recent years. The first departure was probably the mixture of ether and chloroform, with or without alcohol. The rectal administration of ether was then suggested, followed by the use of morphine, the intra-venous, intra-rectal, or intra-peritoneal injection of chloral, the inhalation of chloroform in association with subcutaneous injections of morphine and atropine, and the administration of benzine, paraldehyde, urethane, hypnone, methylene, and amylene. When, as in oxen, the flesh would be used for human food in case of the operation failing, large doses of alcohol are often given.

In general anæsthesia the patient is thrown into a more or less profound artificial sleep. It is not always necessary, however, to act on the entire individual. Sometimes the operation only affects a very limited area, and local anæsthesia suffices. Local anæsthesia is generally produced by the application of ice or freezing mixtures, by

the spraying of certain liquids, like ether, ethyl chloride, or anestile, or by the subcutaneous injection of cocaine, eucaine, or stenocarpine solutions.

Anæsthetics have a less extended usefulness in animals than in man. Pain should be spared as far as possible, but expense must always be considered, and anæsthesia has its drawbacks. For most minor operations, the means of control at our disposal are sufficient without general anæsthetics, but certain operations cannot be performed without them. In reduction of hernia, delivery in cases of dystokia, laparotomy, and in all cases where one works in dangerous proximity to important organs, the animal's struggles render anæsthesia almost indispensable. It is also necessary for delicate operations on or in the vicinity of the eye, and for all serious operations on valuable horses, whose struggles are particularly violent. Möller recommends anæsthesia in castrating horses with very powerful dorsal muscles. In ruminants anæsthesia is seldom resorted to save in difficult parturition. In carnivora, and especially in the dog, its principal indications are in laparotomy, difficult parturition, amputations, and certain operations on the head.

Anæsthesia is contra-indicated (1) in diseases of the heart (lesions of the valves or myocardium, dilatation, and hypertrophy); (2) diseases of the respiratory tract (emphysema, pneumonia, and chronic pleurisy).

Ether is the best anæsthetic for subjects with emphysema and dilatation of the right heart, chloroform for those with affections of the left heart, chloral when the pulse is intermittent (Arloing).

Death may be caused by pushing administration too rapidly: in certain rare cases it may also result from accidents like vomiting, the vomited material passing into the trachea and lungs, and producing mechanical pneumonia. Such a termination is much to be feared in man unless the patient be properly prepared, but it very seldom occurs in the horse. If in operations on the face, such as trepanation of the facial sinuses or nasal cavities, or extraction of molar teeth, an anæsthetic be employed, the head should be placed in a depending position, so as to favour escape of blood, which might otherwise enter the respiratory tract and produce suffocation.

(*a*) General Anæsthesia.

Narcosis being the result of a special action exerted directly on nerve-centres by the anæsthetic agent, the first necessity is to insure a sufficient quantity of the anæsthetic arriving at those centres. While fixed anæsthetics can be administered by various channels, such as the veins, mucous and serous surfaces, the subcutaneous tissue, etc., vola-

tile anæsthetics must penetrate by the respiratory mucous membrane. Injected into the tissues or veins, fixed anæsthetics traverse the pulmonary capillaries without sensible change, and act promptly on the nerve-centres; volatile anæsthetics, similarly administered, escape in large measure through the walls of the pulmonary vessels, are expired, and fail to reach their destination in sufficient quantity to produce much effect. On the other hand, volatile substances, introduced in a state of vapour into the respiratory tract, are freely absorbed by the blood circulating in the lungs, which blood, passing thence to the left heart and general arterial system, rapidly produces anæsthesia.

Anæsthetics administered by the respiratory tract produce a series of phenomena in the following order:—(1) period of excitation; (2) period of anæsthesia or surgical period; (3) period of collapse or intoxication.

The period of excitation, due firstly to the action of anæsthetic vapours on the nerve terminations in the mucous membrane of the upper respiratory tract and paralysis of the cerebral inhibitory centres, and afterwards to the action of these vapours on the great nerve-centres themselves, is characterised by perverted sensation, excitement, and hyperæsthesia of sense organs. Violent struggling occurs, respiration and circulation become accelerated, the mucous membranes injected, and the pupil dilated; the heart's action, however, soon slows, respiration becomes easier, more regular, and more extensive, the pupil contracts, excitement diminishes, and sleep commences. During this period anæsthetics may, in animals predisposed to such complications, produce respiratory or cardiac syncope or asphyxia from spasm of the glottis.

The period of anæsthesia is characterised by suspension of activity in the nerve centres, *i. e.* the cerebral lobes, medulla oblongata, and mesocephalon. The animal is plunged in artificial sleep. The excito-motor centres are paralysed, the muscles relaxed, the limbs when raised fall inertly. Respiration is slow, the movements of the chest wall are diminished, but those of the flank more marked than ordinary. The heart is accelerated, on account of paralysis of the moderator centre, but the pulse remains regular and full up to the moment when intoxication occurs. Vision is no longer co-ordinated, while the pupils remain contracted and immobile. As sensation is lost in the various regions reflexes cease.

Sensation does not disappear simultaneously in all tissues and all regions, being last retained by organs under spinal control. The limbs and trunk are first affected, then the organs of sense and those supplied by branches of bulbar origin, finally those supplied by the sympathetic

Dr. O. P. Sinnerud

system. The nasal, buccal, auricular, and genital mucous membranes exhibit reflexes long after other parts have become insensitive. Even when anæsthesia appears complete, struggling often results immediately the knife touches the diseased region. This is due to certain diseased tissues retaining a morbid sensibility even after neighbouring healthy tissues have entirely lost sensation. Inflamed parts especially retain their sensibility long after healthy tissues. Once established, anæsthesia can be maintained by very small doses of the agent employed; larger amounts are dangerous, as being liable to induce the third stage of anæsthesia, viz. collapse or intoxication. This is characterised by progressive retardation of respiration and circulation, and by sudden dilatation of the pupil. Respiratory movements become superficial and cease for comparatively long periods; the heart's action diminishes, the pulse is small, soft, and irregular. Finally the medulla becomes intoxicated, respiration is arrested, the heart ceases to beat, and death occurs by respiratory syncope.

The phenomena of anæsthesia vary according to whether ether, chloroform, or another anæsthetic is employed. With ether the period of excitement is longer and more pronounced than with chloroform. With certain fixed anæsthetics the phase of excitement is suppressed or little marked. Although the exact action of chloral is still open to discussion, it is known to produce immediate and profound anæsthesia without preliminary disturbance when administered intra-venously. On the other hand, salts of morphine sometimes produce lively excitement prolonged for some hours. The difference, however, interests physiologists more than practitioners. The chief point for the latter is the degree of toxicity of these agents, *i. e.* the danger attending their use. No general anæsthetic is without danger, and even in veterinary surgery, where their employment is limited, every practitioner has probably had a fatal case.

Anæsthesia in the Horse.

Chloroform probably produces the most rapid and complete anæsthesia in the horse. It is not so dangerous for solipeds as has been suggested. The writer, whose experience extends to over four hundred cases, has only seen two fatal results, which occurred after deep surgical anæsthesia had been maintained, in one case for over two hours, and in the other over three. Needless to say, recovery of consciousness is slow after prolonged operations, and the animals may not rise for half an hour to an hour after their termination, but given reasonable care in administration chloroform fulfils all requirements.

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In company with Dr. Clarke, the writer attempted on several occasions to kill animals by the administration of air saturated at ordinary temperature with chloroform vapour, but the experiments all proved the extreme difficulty of the attempt. Where, however, the animal is partially asphyxiated, as in using several of the common veterinary inhalers, death can be produced in eight to ten minutes. By using a special apparatus, by means of which absolutely pure chloroform vapour, *without admixture of air*, was administered, death was produced in one and a half minutes. The heart's action continued for several minutes after respiratory arrest. Möller, who employs chloroform exclusively, has administered it to more than 500 horses without a single accident.

As a basis for investigation, Möller noted in each of his cases the time required to produce surgical anæsthesia, the amount of chloroform used, the breed, age, sex, and weight of the animal. The following is a *résumé* of the more important results. In the case of 126 horses (31 stallions, 38 mares, and 57 geldings) anæsthetised with chloroform, the corneal reflex was abolished in an average period of 20 minutes by the administration of an average quantity of 28 fluid drachms of chloroform; the quantity per unit of body-weight was 1 : 4000; anæsthesia usually lasted about 20 minutes.

Whilst in one to two years old foals 4 to 5 drachms of chloroform usually produced anæsthesia in 7 to 8 minutes, the shortest time observed in full-grown horses was in one case 8 minutes, in one case 9 minutes, and in two cases 10 minutes. Twelve of the above 126 horses required 30 minutes, and four from 30 to 40 minutes. In stallions the average period was 18, in mares 19, and in geldings 22 minutes. The stallions on an average consumed 30 drachms of chloroform; 7 horses (3 stallions, 2 mares, and 2 geldings) took, however, less than 12½ drachms; on the other hand 18 (5 stallions, 4 mares, and 9 geldings) required 38 fluid drachms or over. One gelding received 60 fluid drachms, and an English thoroughbred 62½ fluid drachms. The average age of the stallions was 5, of the mares 9, and of the geldings 7 years.

It is worth noting that the quantity of chloroform used depends partly on the method of administration. Apart from the quantity lost by leakage or evaporation, less is required when administration is slow than when it is rapid. The quantity used, therefore, often stands in inverse proportion to the pre-anæsthetic period.

Breed seems to have little relation to the anæsthetic influence of chloroform: it neither affects the quantity required nor the pre-anæsthetic interval to any appreciable extent. On the other hand, it was noted that geldings on an average required considerably more chloroform than stallions and mares.

Twenty-eight horses received subcutaneous injections of 7½ grains morphine before administration of chloroform. In these cases the average quantity of chloroform used was 24 fluid drachms, and the time interval before complete anæsthesia 15½ minutes.

Eight horses were given a mixture of equal parts chloroform and ether. The average quantity used was 54 fluid drachms, and the time interval 30 minutes.

Needless to say the sample of chloroform used must be pure, and should contain no free chlorine, which produces excessive irritation. To prevent chloroform undergoing change by keeping, a little ether is added to it and the liquid placed in yellow bottles with ground stoppers and stored in a cool dark place. Another method consists in adding 1 part in 1000 of sulphur which has previously been washed with ammonia, and afterwards with water.

Partial Anæsthesia by Chloroform. — As anæsthesia by chloroform is generally preceded by a short excitation period, during which the animals neigh, become uneasy, and often struggle violently, casting by hobbles or on an operating table is an almost unavoidable preliminary. This, of course, is a drawback, especially when an operating table is not available, and if general anæsthesia could be carried out in the standing position it would prove a great convenience. The writer frequently tested this method, and for some time had such satisfactory results as almost to convince him of its general practicability, but an attempt to chloroform a heavy cart-horse for shoeing was followed by such disastrous consequences, and so gravely endangered the operator's own life, that he finally renounced the method for any but light animals. Ponies, cobs, and light saddle and trap horses may be anæsthetised in the standing position by the use, preferably, of Cox's inhaler. A strong head collar or halter should be applied, and the animal firmly secured, as greater danger is to be anticipated from its becoming loose than from throwing itself down during the preliminary period of anæsthesia. Administration should be slow as excitement is thus best avoided. The writer has found that many animals will stand quietly until the corneal reflex becomes quite languid, and is almost abolished. This is the best condition for shoeing troublesome horses. If cutting operations are in question, anæsthesia must be pushed considerably beyond this stage, and the animal will certainly fall, a result, however, which need be productive of no inconvenience if a deep straw bed has previously been provided.

Apparatus. — Chloroform can be administered from a towel, sponge, tampon of tow, or a linen compress, but in England Cox's or Carlisle's muzzle is usually employed. Although the rapid method is

considered dangerous by some, it is that most commonly used in England.

Abroad great precautions are taken. The chloroform is given from a compress, and by one nostril only, being added drop by drop at the rate of two or three drops per second. To avoid irritation, produced by the liquid coming in contact with the skin or mucous membrane, the nose may be smeared with vaseline.

Being very volatile, chloroform can be given by a modification of Junker's apparatus. In its simplest form this consists of a tall glass cylinder, containing the anæsthetic, closed by a bung or large rubber cork pierced with two holes, giving passage to wide glass tubes. One tube passes to the bottom of the glass; to this is affixed the bellows; the other, which only just passes through the cork, is provided with a rubber tube which can be slipped into the animal's nostril. By working the bellows, air is forced through the liquid, becomes charged with the anæsthetic, and, passing into the nostrils, is inhaled. A large form of this apparatus, made in copper and worked by a foot bellows, was very successfully used by Dr. Clarke (who invented it) and myself during 1887–9 in operations for roaring. The glass bottle was replaced by a copper cylinder about fifteen inches in height and four in diameter, the glass tubes by large metal tubes about three quarters of an inch diameter. The long tube passed to the bottom of the copper cylinder and through a circular plate of perforated metal. The blast of air was thus broken up into innumerable small bubbles, which became thoroughly saturated with the anæsthetic vapour. As after prolonged use the apparatus grows extremely cold, and is apt to become clogged from the freezing of water vapour derived from the blast of air, it was found advantageous to place it in a bucket containing warm water. Later forms of Dr. Clarke's apparatus are surrounded with an outer metal receiver for containing hot water.

A simple form of inhaler was suggested by Mr. J. Roalfe Cox, F.R.C.V.S. It consisted of a leather tube covered with stout canvas, which could be drawn together at either end by a strong drawstring. The tube was slipped over the animal's nostrils and into its mouth, the drawstring tightened and attached to the halter. A sponge saturated with the anæsthetic was then introduced, and the supply of air controlled by regulating the size of the external opening. The Carlisle inhaler is more complicated, but probably not more efficient. It envelops both the upper and lower jaw, thus differing from Cox's, and is provided with a metal sliding sponge-holder on which the chloroform is poured. As sent out it gravely impedes respiration, and for

use the writer has modified it by removing the lower solid end, so that the only obstacle between the animal's nostrils and the outer air is the comparatively pervious layer of sponge for receiving the chloroform. Thus altered it uses rather more of the anæsthetic, but is infinitely safer.

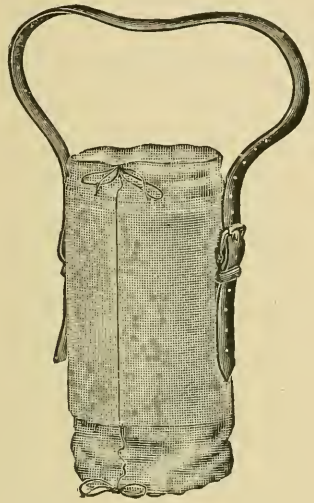


FIG. 67.—Cox's chloroform muzzle.

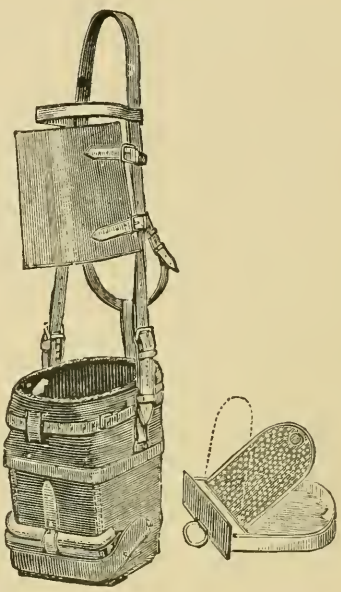


FIG. 67*a*.—Arnold's modified Carlisle chloroform muzzle.

SURGICAL ANÆSTHESIA BY CHLOROFORM.—Chloroform is usually administered as follows:—Food having, if possible, been withheld for twelve hours, the horse is cast, and girths or other impediments to free respiration loosened or removed. During inhalation, attention must be given to the breathing and the pulse. Both are at first accelerated, but later become regular. Unless when using one of the *anæsthesia cum asphyxia* muzzles, the excitation stage is seldom attended with danger, only lasts a minute or two, and is succeeded by the period of depression.

The first stage of anæsthesia (excitation) is often accompanied by a peculiar rotary movement of the eye (nystagmus); in some animals the eyelids close, opening again when anæsthesia is complete. If, soon after the period of excitement has passed, respiration or circulation becomes impeded, or if respiration be laboured, very rapid, or interrupted, if the pulse be small, frequent, irregular, or intermittent, administration must be stopped. General muscular twitching may also occur, and

calls for similar precaution. Rattling in the throat, a serious symptom in man, is of less importance in horses. In the event of its occurring, the tongue should be grasped and drawn forward. Even then the noise does not always cease, being probably due to vibration of the relaxed soft palate, which is set in motion by the stream of air passing through the mouth during respiration.

The loss of sensibility, muscular weakness, character of the pulse and respiration, variation in the pupil, and the persistence or loss of the corneal reflex indicate the degree of anæsthesia.

Complete anæsthesia is characterised by disappearance of the oculo-palpebral reflex and contraction of the pupil. At this stage should the conjunctiva or cornea be touched no movement of the eyelids follows, and touching the cornea has therefore become the usual test of anæsthesia. When the corneal reflex ceases inhalation may be stopped, to be resumed with its reappearance. The test is doubly valuable: it shows anæsthesia to be complete, whilst its disappearance is usually long antecedent to the period of intoxication. Too much weight, however, cannot be attached to the advice "**watch the breathing.**" The breathing, and *not* the pulse or any other sign, is the only safe guide in administering an anæsthetic. The abolition of the corneal reflex usually occurs long before respiration is endangered, so that it is a *convenient* guide; but its occurrence is subject to irregularity, and it must never be relied on to the exclusion of the breathing.

Variations in the pupil also afford valuable information. As anæsthesia becomes pronounced, the pupil, dilated during the period of excitement, contracts. During anæsthesia it remains contracted and immobile, dilating slowly as sensibility returns. Rapid dilatation at an advanced stage of anæsthesia is a sign of bulbar intoxication and of imminent syncope.

When the corneal reflex is lost and the pupil contracted, sensibility has disappeared, and muscular relaxation is complete. Provided respiration and circulation continue regular, anæsthesia can then be prolonged for periods of two or even three hours without danger by occasionally administering further small doses of chloroform.

On completion of the operation the hobbles are removed; but the horse is left undisturbed until it rises of itself, which will usually happen in a quarter to half an hour. Should the animal be forced to rise before consciousness has entirely returned, it walks unsteadily, "bores" forward like an animal with brain disease, and may fall. To support it an assistant may walk on each side, with a hand on the point of the hip, and one behind holding the tail.

Administered with the foregoing precautions chloroform becomes

a perfectly safe anæsthetic for the horse, and though individual animals show special susceptibility to its action, yet in general the danger is infinitely less than was formerly imagined.

Fatal issues result either from asphyxia or syncope.

Asphyxia usually occurs during the period of excitation, especially if some closed muzzle like the Carlisle muzzle or its modifications be used; first breathing stops, and after a short interval the heart's action fails.

Asphyxia may also happen towards the end of the anæsthetic period if administration has been pushed far and is suddenly checked. In such case the sides of the chest, face, or lips should be smartly struck with the hand or a wet towel to provoke reflexes and restore respiration. When arrest continues for an appreciable period (the writer has timed arrests of thirty to forty-five seconds), artificial respiration may be resorted to. A fairly heavy assistant stands between the animal's legs and presses with his entire weight on the animal's chest, rising again almost immediately. This is repeated at intervals of about four or five seconds. The shock should not be violent; but the man's whole weight should be employed, and special attention must be given to regularity in the process. In the horse it rarely happens that the tongue recedes and by covering the opening of the larynx causes asphyxia. Should any indication of this—like loud snoring, etc.—occur, the tongue should immediately be grasped and drawn forward.

In cases of respiratory failure some French investigators have recently recommended the system practised in man for resuscitation from drowning, viz. repeated rhythmical traction on the tongue (lingual traction) at intervals of two to four seconds. The theory is that the superior laryngeal nerve and respiratory centre are thus stimulated, and in man remarkable effects have been produced, more than one person having recovered after apparent respiratory arrest extending over an hour. A small apparatus worked by electricity has been made to carry out the process.

Impending **Cardiac Syncope** is indicated by irregularity of the pulse, widely dilated pupil, weak heart's action, cessation of hæmorrhage, or the escape of a few drops of dark-coloured blood from the seat of incision. The head should immediately be lowered as far as possible, artificial respiration commenced, cold water dashed on the head, the chest wall smartly slapped, and if time permit, subcutaneous injections of sulphate of strychnine or ether should be given. Cardiac syncope may also be combated by intermittent pressure on the heart region, at the rate of 120 to

140 times per minute, or by the intra-venous injection of warm normal salt solution. Hobday recommends small doses of prussic acid. Rosenberger believes that in man heart failure is due to stimulation of the vagus, owing to irritation of the respiratory mucous membrane by the chloroform vapour; he recommends previously painting the membrane with cocaine solution. The precaution is unnecessary in horses. In proof of the irritation produced, however, one may often note in well-bred horses certain symptoms of sore throat, such as coughing, etc., during the few days next succeeding the operation. Recovery usually occurs without treatment.

Morphine and Chloroform.—When morphine is previously administered the animals sometimes show considerably more excitement than when chloroform alone is employed; and as, generally speaking, the preliminary use of morphine neither lessens the pre-anæsthetic period nor decreases the amount of chloroform required, it is rather a drawback than a help. Chloroform and ether mixtures present no advantages over chloroform alone, except in cases of heart affection.

Ether was the first and, in man, remains the favourite anæsthetic. It is administered in progressive doses from a sponge, tampon of tow, or linen compress, or by means of Cox's or Carlisle's inhaler. An ordinary deep leather bucket muzzle is a very good substitute, provided care is taken to prevent the liquid coming in contact with the mucous membrane of the nostril. If necessary, inhalation is occasionally stopped, and when surgical anæsthesia is complete the dose is considerably reduced. During the whole time respiration and the reflexes must be closely observed.

The horse having been cast, anything which might impede respiration, or compress the larynx, the lower portion of the neck, or the thorax, is removed. If Cox's muzzle be employed the procedure is precisely similar to that in giving chloroform; otherwise a linen pad about eight to ten inches square is placed over the nostrils, and ether dropped on it in small quantities. The distance from the nostrils regulates the rapidity of administration and the amount given.

The mucous membrane of the upper respiratory passages being irritable, considerable excitement is at first produced; the animal neighs, struggles, and is sometimes very violent; respiration and circulation are accelerated. This stage sometimes lasts for ten minutes, and is succeeded by that of surgical anæsthesia.

The quantity of ether used is often considerable, from ten to twenty fluid ounces, sometimes even more. Recovery is slower than after chloroform.

Though less dangerous than chloroform, ether is not, as some

suggest, absolutely innocent, and has claimed a number of victims in human surgery. Nevertheless Gurlt's statistics show the mortality from chloroform to be fifteen times greater than that from ether.

Anæsthesia can be produced by the introduction of ether vapour into the rectum. It was tried first on animals by Dupuy and Thiernesse, adopted for man by Pirogoff (1847), and recently by Daniel Mollière (1884), and has been recommended by Cagny for the purpose of producing a certain degree of drowsiness in horses to facilitate casting or to permit of trifling operations in the standing position. The system is simple; a flask or tube with a narrow neck is partially filled with ether; one end of a rubber tube is slipped over the neck, and the other end introduced into the rectum. The flask is placed in water heated to 120° F. Ether vapour is at once given off, enters the rectum, and is absorbed by the mucous membrane. One and a half to two ounces of ether are sufficient. Experience does not show this method to have any marked advantages. In place of partial anæsthesia active excitation often follows. Such violent expulsive efforts are sometimes made as to produce rectal prolapse. In man cyanosis, collapse, and even a kind of asphyxia have resulted. The uncertainty and serious inconvenience of this method have prevented its being commonly adopted. Mixed anæsthesia, produced by the injection into the rectum of ether vapour and the subcutaneous administration of morphine and chloral, is slow in its effects and of little practical utility.

In English human surgery a favourite method is to obtain anæsthesia with nitrous oxide and maintain it with ether. The method has many advantages, and has come largely into use.

Chloral is usually injected intra-venously, alone or after hypodermic injection of morphine. Intra-venous injection of 20 to 33 per cent. solutions produces very rapid and complete anæsthesia. Though declared dangerous by human surgeons, this method has been recommended in France and Denmark for the horse, on account of the ease with which injections can be made into the jugular. The solution, which may be of any strength between 10 and 33 per cent., must be freshly prepared, and should contain a little carbonate of soda to insure its being alkaline.

Intra-venous injection requires very special precautions. The point of operation must be thoroughly disinfected, and all instruments should be sterilised. Everything being ready, an assistant compresses the vein low down in the jugular furrow; the operator then draws the skin in the direction of the head with one hand, while with the other he thrusts a needle or fine trocar into the distended vessel, taking a very oblique course from above downwards, *i. e.* almost parallel

with the vessel. Humbert recommends dividing the operation into two stages, first dividing the skin, then, after having raised the vein, introducing the needle or trocar. When the operation is done standing he chooses by preference the right jugular. The discharge of a little jet of blood through the cannula when the trocar is withdrawn shows that the operation has been well performed. An assistant holds the cannula firmly, and inclined towards the general line of the neck. The operator next introduces into the opening of the cannula a special metal plug connected to a rubber tube, which slips over the nozzle of the injecting syringe, and opening the tap, injects the necessary quantity of chloral solution; needless to say, great care must be taken not to inject air. The operation concluded. he frees the cannula from the rubber tube, allows a little blood to escape, and quickly removes the cannula, supporting the skin meanwhile with the fingers of the left hand. Colin gives the dose as two and a half to three and a half drachms; Arloing three to six drachms; and Nocard one and a quarter drachms per hundred pounds of body-weight. Anæsthesia appears almost immediately. It is more or less profound, and continues for a greater or less time according to the amount of chloral injected. In a few seconds the animal is asleep, the muscles are completely relaxed, the mucous membranes slightly cyanotic, and the respiration and circulation, though disturbed for a moment, rapidly recover their normal rhythm. The animal recovers slowly, remaining stupefied for a time, and sometimes suffering from general trembling of the body muscles. At the end of half an hour to two hours the horse rises, resting for a time on its haunches. Movement of the hind limbs is irregular and uncertain. This weakness sometimes persists for one or two hours.

When the dose has been too large, or the subject is specially susceptible to the action of chloral, the sleep is very deep, the mucous membranes become darker and darker in colour, the pupil dilates, respiration and circulation become slower and slower, the temperature falls, and death may result.

If the operation be not performed antiseptically, if the opposite coat of the vein be injured when introducing the cannula, or if the solution obtain entrance to the perivenous tissue, grave results almost always follow. The majority of those who have tried this method have had at least some cases of phlebitis, and, in consequence, have abandoned it. Phlebitis usually appears between the second and fourth days; a swelling, sometimes circumscribed, sometimes diffused, occurs in the jugular furrow. Suppuration follows; frequently

a portion of tissue becomes gangrenous. In one case mentioned by Cadiot the vein was destroyed throughout almost the entire length of the neck. Furthermore, chloral acts as a vaso-dilator, increasing hæmorrhage during operation. Finally, although it has been little used, chloral is responsible for a considerable number of deaths. Möller killed a number of horses by injecting twelve and a half drachms in solution. As the horses were not weighed, it might be said that this dose was too large, but Cadiot has had a death with the prescribed dose, where the quantity administered did not exceed one and a half drachms per hundred pounds of body-weight. Fifteen to twenty minutes after administration, when the operation was almost complete, respiration ceased, and a few seconds later death resulted, despite efforts made to establish artificial respiration.

Although when performed antiseptically and by skilled operators intra-venous injection may be innocent, it has given such bad results in the hands of the majority that it has been renounced, among others, by veterinary surgeons of the eminence of Peuch, Trasbot, Möller, and Cadiot.

Administered by the mouth in doses of ten to twenty drachms diluted solutions of chloral produce drowsiness, loss of co-ordination of movement, but not complete anæsthesia. The method, however, is of value in practice.

Chloral and Morphine.—To avoid the accidents resulting from intra-venous injection of chloral Cadeac and Malet associated chloral with morphine. They claim to produce complete anæsthesia by subcutaneously injecting a solution of fifteen grains of hydrochloride of morphine, and at the end of ten minutes giving an enema containing twenty to twenty-five drachms of chloral.

Anæsthesia is not always produced. It appears slowly, and sometimes only after prolonged excitement. Esser recommends this method where chloroform is contra-indicated.

Morphine, in the form of subcutaneous injection, has been recommended to quiet small animals, and in the horse to produce slight anæsthesia for trifling operations in the standing position. According to the animal's size the dose varies from three to seven grains. In certain horses morphine produces somnolence and more or less pronounced relaxation of muscular tissue. Irritable or even dangerous animals become quiet and easy to handle. Others, however, even after large doses, show excitement lasting several hours. The patients act violently, exhibit disordered movements, kick, and thrust their heads against the wall, as in indigestion complicated with brain mischief. Morphine must, therefore, be considered uncertain as an

anæsthetic; nevertheless, it renders some service, and in small doses is devoid of danger. Opium or Indian hemp is, however, usually preferable.

Methylene is inferior to chloroform, as are hypnone, urethane, paraldehyde, and benzine. Inhalations of the latter substance first produce excitement, in about ten minutes distinct dulness, and later a quiet sleep, which can be prolonged by fresh inhalations.

Anæsthesia in Ruminants and Swine.

Anæsthesia is seldom resorted to in ruminants or in the pig. Tabourin and Saunier, who made a long series of experiments with **chloroform and ether**, came to the following conclusions:— 1. That in oxen, ether produced anæsthesia without difficulty. 2. That the animals succumbed to its action more readily each time anæsthesia was repeated. 3. That chloroform was so much more energetic than ether as to warrant its entirely displacing the latter, despite its higher price. Given by the mouth 12 to 18 fluid drachms of chloroform only produced incomplete anæsthesia.

Fröhner failed to obtain any anæsthetic action from doses of 10 drachms of **chloral**; given by the mouth, 6 to 10 drachms produced unsteadiness of the hind quarters in fifteen minutes; 12 to 18 drachms, however, caused the animals to fall and lose consciousness and sensation; unconsciousness lasted three hours. Negotin recommended this method and dose.

Guinard found **morphine** useless in ruminants, and especially in goats; it failed to produce even a sedative effect. Goats are not injured by 400 times the full dose for man.

Malzew gave ten oxen **chloroform** in combination **with morphine.** Two to three grains of morphine were subcutaneously injected, and three to twelve minutes later chloroform was administered. In seven cases anæsthesia commenced after the lapse of ten to forty minutes, in three it could not be induced. From 4 to 19 fluid drachms of chloroform were used. On return of consciousness none of the oxen showed anything abnormal. Goats and sheep are easily anæsthetised in five to ten minutes with $2\frac{1}{2}$ to 5 fluid drachms of chloroform.

In general the above also applies to swine, and chloroform would probably prove the best material; Negotin found it harmless.

Harms succeeded in abolishing sensibility to pin-pricks in ten minutes by giving benzine vapour. Chloral hydrate is often given to cows when calving, in order to dull labour pains; complete anæsthesia is, of course, unnecessary.

As, however, in the event of operation failing oxen may afterwards require to be slaughtered, alcohol is usually preferred to any substance which might taint the flesh. Most practitioners give a large dose of alcohol or rum; in the case of oxen, one to two pints. In five to ten minutes the action begins, and as intoxication proceeds the muscles relax.

Anæsthesia of the Dog and Cat.

Ether or Chloroform may be used; the latter is preferable. Respiration may take place by either the mouth or nose, but it is dangerous to forcibly close the jaws, especially by muzzling the animal with tape. Guinard lays special stress on the need for keeping the dog's mouth open while giving chloroform; given by the nose alone chloroform is apt to produce so active a stimulation of the vagus as sometimes to inhibit the heart's action.

The dog is placed on its chest or side, the jaws opened, or fixed in an open position by a gag. Chloroform can be given by applying to the animal's nostrils a pad of tow or a small sponge moistened with chloroform. Another method is to form a cone of stout brown or blotting paper, at the bottom of which is placed a small loose ball of cotton wool to receive the chloroform. A conical muzzle, like Krohne's for human use, or an ordinary Junker's inhaler is probably the most convenient apparatus, though necessarily more costly than the paper cone. Whatever the method adopted, administration should always be slow.

Ether is given in a similar way, but the excitation period is longer, and the slumber produced less deep. On the other hand, ether anæsthesia may be prolonged for considerable periods without danger.

Hueppe claims to have produced anæsthesia in dogs by injecting $2\frac{1}{2}$ drachms of ether into the external ear.

To obtain more rapid narcosis, and diminish danger of collapse, **morphine** has been recommended in combination **with ether or chloroform.** Möller first injects from three quarters to one and a half grains of hydrochloride of morphine hypodermically, and after a short interval gives ether in the usual way.

Cagny administers ether vapour by the rectal mucous membrane. Its action, however, is uncertain, and it sometimes causes violent straining.

As in the horse, intra-venous injection of chloral is dangerous.

Morphine in the form of subcutaneous injection, **and chloral** in enema, have been advantageously combined. The dose of morphine is at the rate of two minims of a 2 per cent. solution, and of chloral

seven and a half grains, per pound of body-weight. Roucher has slightly modified this method. The bowel is cleared with a soap and water or glycerine enema, and a subcutaneous injection of morphine in the proportion of $\frac{1}{50}$th grain of hydrochloride of morphine per lb. of body-weight administered, followed by an enema of one drachm of chloral hydrate in linseed emulsion. If necessary the dose may be repeated in seven to eight minutes; very large dogs may require a third, or even a fourth. The disadvantages are the same as in the horse. Anæsthesia is slow and hæmorrhage abundant.

Richet has recommended intra-peritoneal injections of chloral alone or associated with morphine. Injected into the peritoneum chloral produces complete anæsthesia in about ten minutes. The injection is made with a Pravaz's syringe, the greatest care being taken in regard to asepsis. When well diluted, chloral is tolerated by the peritoneum. Morphine added to the chloral prolongs anæsthesia to about one hour without danger of syncope. In this method the doses are, hydrochloride of morphine ·02 grain, chloral four grains, per pound of weight. The method, however, does not seem to have proved permanently successful, dangerous complications sometimes occurring.

Fröhner regards urethane as one of the best agents for the dog, and has tried hypnone and paraldehyde with good results. Desoubry gives from 22 to 30 grains of sulphonal to dogs of 40 lbs. body-weight, and highly praises the method.

In the dog and cat, however, the best method probably consists in using **chloroform after** a preliminary injection of **atropine and morphine.** The morphine modifies excitement at the commencement of anæsthesia; the atropine prevents cardiac syncope by suspending the function of the cardiac moderating centre and of the arresting fibres of the pneumogastric. The solution is prepared as follows:

Hydrochloride of morphine . . .	3 grains.
Sulphate of atropine	·3 grain.
Distilled water	2½ fluid drachms.

This solution is injected in the proportion of five minims per pound of body-weight. In twenty to twenty-five minutes the solution produces its effect, and chloroform inhalation can be commenced. A drachm or two is sufficient to produce complete anæsthesia, which can be prolonged for one or two hours. The solution used in man is as follows:

Hydrochloride of morphine . . .	1½ grains.
Sulphate of atropine	·08 grain.
Distilled water	2½ fluid drachms.

This solution is also preferable for the dog. Ten minims are given to animals of small size, twenty to forty minims to animals of medium size, and sixty to eighty minims to large dogs. Chloroform is administered at the end of twenty-five minutes. This method produces deep and prolonged anæsthesia. There is no danger of syncope.

The cat is very susceptible to the action of most anæsthetics. Death may result from giving an overdose, from pushing the anæsthetic rapidly, or from prolonging its action.

A convenient method consists in placing the animal under a bell-jar containing a small sponge or a tampon of wadding saturated with chloroform. The animal soon loses consciousness and falls, when it is removed and the operation performed. This method, however, is not without danger; the period of anæsthesia is short, and if repeated inhalations are given there is some danger of the animal succumbing. A modified Junker's apparatus is preferable. Müller, of Dresden, confirms the common experience that cats are poisoned in a few minutes if chloroform be given rapidly, although they bear considerable doses of ether very well. Forty-five grains of chloral hydrate in the form of enema also proved fatal.

The combination of atropine, morphine and chloroform, as given above, may be employed, but the cat, being extremely sensitive to the action of morphine, which in it produces great excitement, the dose should not exceed ·002 grain instead of ·02 grain per pound of body-weight. Guinard recommends another method permitting of prolonged anæsthesia. He gives a hypodermic injection of hydrochloride of morphine at the rate of ·02 grain per pound of body-weight, and at the end of a quarter of an hour to twenty minutes, when excitement diminishes, he places the cat under a bell-jar with a sponge saturated with chloroform. The animal should be removed when anæsthesia first appears, but inhalation is best continued for a few moments afterwards. Thus obtained, anæsthesia can be kept up for forty-five minutes. The excitement due to morphine reappears as anæsthesia diminishes, and may persist for some time.

Negotin recommends Billroth's mixture (chloroform 3 parts, ether and alcohol āā 1 part) or Wachsmuth's (chloroform 5, rectified oil of turpentine 1 part) for dogs and cats. The ordinary A.C.E. mixture (ether 3, chloroform 2, alcohol 1) is better than equal parts of ether and chloroform.

Negotin had indifferent results in carnivora and horses with bichloride of ethylene, and in cats and dogs with bromoform.

Monkeys may be placed in a close cage covered with a cloth, and containing in one corner a tampon of cotton wool saturated with chloroform. The animal at first struggles, and then begins to fall about the cage or to lean against the walls, at which stage it is removed; if the operation lasts for some time a further inhalation is given.

Birds may be placed under a bell-jar containing a sponge or cotton-wool tampon saturated with chloroform. One edge of the jar may be slightly raised to allow air to enter. Hering states that birds may be hypnotised by placing the head under one of the wings, and then rapidly turning the bird's body several times around its long axis.

Conclusions regarding General Anæsthesia.—The above conclusions may be summarised as follows:

1. For horses the best anæsthetic is chloroform (inhaled) in doses of 1 to 8 fluid ounces; average dose, say, 3 ounces.

2. For oxen: chloral hydrate, in doses of 12 to 20 drachms, or whisky, brandy, or spirit in doses of 1 to 2 pints.

3. For sheep, goats, and swine: chloroform (inhaled) in doses of $2\frac{1}{2}$ to 5 drachms.

4. For dogs and cats: morphine (subcutaneously) in doses o ·75 to 1·5 grains, or equivalent doses of morphine and atropine, followed by inhalations of ether, chloroform alone given in small, carefully-increased doses, or mixtures of chloroform with ether, alcohol, or oil of turpentine.

Surgical Anæsthesia by the Injection of Cocaine into the Lumbar Subarachnoid Space.*

The event of the surgical year 1900 in Paris was undoubtedly the impetus given by Tuffier to the method of inducing anæsthesia by medullary injections of cocaine, a suggestion previously made and acted upon by Bier, of Kiel, Seldowitsch, of Russia, and Corning, of Chicago. Tuffier was first led to use it as a means of relief in the case of a young man suffering from an inoperable osteosarcoma of the ilium whom morphia failed to relieve. The result of the injection of cocaine was striking. The patient, who was crouching down in the position of greatest ease, felt the pain disappear in a few minutes, and was even able to rise. There was at the same time absolute anæsthesia reaching to the umbilicus. Unfortunately the relief lasted only a few

* See 'Lancet,' January 12th, 1901.

hours, and the injection was repeated two days later with similar effect, pressure over the tumour for some hours causing no pain whatever. A few days later a similar injection was tried for a patient with a recurrent sarcoma of the thigh, and to Tuffier's surprise he was able to remove the tumour completely with absolutely no pain to the patient, the anæsthesia lasting over an hour. At first, therefore, used only in the surgery of the lower limbs, Tuffier rapidly extended its use to operations upon the perinæum, the rectum, the anus, the bladder, the ureter, the kidney, and such laparotomies as hysterectomy, removal of the appendix, and even gastro-enterostomy. Finally, removal of the breast has been effected with complete anæsthesia. Convinced of the absolute harmlessness of the injections, Tuffier then used them in general gynæcology, and performed such operations as hysteropexy, drainage of salpingitis, ovariotomy, vaginal hysterectomies, etc., with equal success.

Technique.—The details of the technique followed were given in the *Semaine Médicale* of May 16th, 1900, and later Tuffier was careful to disclaim any originality, save in some practical technical points of his procedure. An ordinary hypodermic syringe will suffice, provided its construction admits of absolute sterilisation. The best, therefore, is the glass syringe made by Luer, which can be boiled without injury, and which never gets out of order. The needle should be strong, of platinum, about nine centimetres in length—*i. e.* three and a half inches—with its penetrating sharpened portion cut very short. The solution of cocaine used is 2 per cent., and must be freshly prepared and sterilised. It seems, however, probable that in the long run weaker solutions will become of more frequent use, and that the solution of cocaine used will vary from 1 in 100 to as little as 1 in 400. The patient should be seated bent forward slightly, with both arms in front of him. The lumbar region is thoroughly cleansed, and the anatomical landmarks are noted. It will be found that a horizontal line between the two highest points posteriorly of the iliac crests passes immediately below the fourth lumbar spinous process. Above or below this line in the intervertebral space the needle will freely enter the medullary canal. The left index then marks the fourth spinous process, and the patient is told to bend well over forwards, thus increasing the space between the vertebræ by nearly three fifths of an inch. The needle alone is then entered at about a centimetre (two fifths of an inch) to the right of the middle line, in a direction forwards and inwards in the third or fourth lumbar interspace, as may be selected. The third lumbar interspace is that commonly chosen, but the fourth may be punctured with equal facility and effect, and Legueu frequently injected the cocaine into the second lumbar space. It is interesting to recollect that Corning's first injection was made between the twelfth dorsal and the first lumbar vertebra. The needle thus pierces the skin, the subcutaneous tissue, the lumbar fascia, the sacro-lumbar muscles, and the quadratus lumborum, and enters the spinal canal through the ligamentum flavum, which alone offers any noticeable resistance.

As the needle enters the subarachnoid space the absence of

resistance is at once felt, and almost at once the clear, yellowish cerebro-spinal liquid escapes drop by drop. The syringe has been already prepared, containing from one to two cubic centimetres of the 2 per cent. solution, *i. e.* from one to two centigrammes of cocaine (from twenty to thirty minims, containing about a quarter of a grain of cocaine), and is now fitted to the needle, and the solution is very slowly injected. The quantity of cocaine injected, it will thus be seen, is very small, and yet the anæsthesia resulting will last about one and a half hours. The little puncture is then sealed with collodion, the patient lies down, and an assistant at once begins to cleanse and to prepare the field of operation. The analgesia passes gradually from the feet upwards, and for a laparotomy it may be necessary to wait from ten minutes to a quarter of an hour before commencing.

Tuffier, whose experience is probably greatest of living surgeons, has not yet observed an accident which he could attribute to the injection or to the cocaine. He has by this method performed over 200 operations, of which more than half have been intra-peritoneal. Legueu prefers eucaine to cocaine, owing to its lesser toxicity and its greater stability during sterilisation by heat. Hydrochloride of eucaine may be sterilised either in an autoclave or by heating the solution for half an hour on three successive days to 100° C. Hydrochloride of cocaine, on the other hand, will decompose at this temperature. Legueu's conclusion, after some weeks' experience and over fifty operations, is that as a method of anæsthesia it is destined to take an important place in a great number of operations, and specifies all below the level of the umbilicus, all operations on the perinæum, the lower urinary passages, the lower limbs, always supposing that muscular contractions do not too greatly embarrass the surgeon. Some drawbacks, such as incompleteness of the anæsthesia produced and signs of poisoning, have been noted by one or two observers.

Messrs. Cuillé and Sendrail, of the Toulouse Veterinary School, have tested this method in the horse, ox, and dog. They report that their first experiments have given complete satisfaction.

Horse.—They employ a trocar about 4 inches long by $\frac{1}{16}$ of an inch in diameter. The place where the puncture is made is found midway along a line joining the internal angles of the two ilia. Implanted vertically at this point the trocar enters the neural canal, traversing the lumbo-sacral space. It is the only accessible spot; further forward the vertebral laminæ are too close together and imbricated. During the operation the animal scarcely moves. The application of a twitch and the lifting of a fore-foot are the only precautions required. Disinfection of the cutaneous surface, sterilisation of the needle, syringe, and solution, are absolutely necessary.

First experiment. Aged mare. Injection of 1 fluid drachm of 2 per cent. solution of cocaine. Five minutes later the subject rocked slightly; when made to move she showed weakness behind, and went over on her side. The students practised neurectomy on all four legs. Cutting through the nerves of the hind limbs caused no pain, but section of the nerves in the fore-limbs produced pain, manifested by struggling of all the limbs.

In the second case the operation of ovariotomy was performed without any exhibition of pain.

Third experiment. Aged mare, medium size. Injected 30 minims of cocaine solution. The gait was like that of the former animal. Ten minutes later ovariotomy was performed without any movement whatsoever ("dans le calme le plus parfait"). The sensibility of different parts of the hind limbs, flanks, and lower aspects of abdomen was tested by pyropuncture; there were no signs of pain. Plantar neurotomies were performed upon the hind limbs forty minutes after the injection without pain, the animal lying down.

Bovines.—The same trocar as for the horse was used. Puncture was made at the same point. Leaving aside the toughness of the skin, the operation is easier than in the horse, the lumbo-sacral space being a little wider.

Sixth experiment. An old Lourdes cow. Injected 75 minims of 2 per cent. solution of cocaine. Three minutes later the animal flexed her hind limbs; after five minutes she showed weakness, and for a short time literally sat down; then she lay down on her side. Pricked deeply in different parts of the hind limb, she did not move. When the prickings were done in the fore-quarters as far as the line of cartilages of the asternal ribs, she showed pain. An hour later the animal got up voluntarily. The spinal cord, spinal meninges, and cauda equina were perfectly normal.

Dog.—The best point for the operation is again in the lumbo-sacral region, taking the same landmarks as before. A hollow needle of a Pravaz syringe, $2\frac{1}{4}$ inches long and $\frac{1}{25}$ inch in diameter, is the most suitable. The animal stood up, the head kept firmly in position by an assistant, but did not resist the operation.

Ninth experiment. A male mastiff of average size received 30 minims of the cocaine solution. Several minutes later he fell upon his hind quarters, the limbs extended, and progressed by means of the fore-limbs as an animal attacked with complete paraplegia. Sensibility was tested by the aid of the zoocautery, and was found to be non-existent behind the hypochondriac regions, but preserved in front. Forty-five minutes later the animal got up, and sensation only commenced to reappear at the end of an hour. The dog then went to his kennel and ate his food with relish.

Tenth experiment. Made upon the same animal the day following the previous experiment. The animal did not appear to have suffered from the experiment of the previous evening. He received 15 minims of the solution. Five minutes later the gait was somewhat altered, but walking was still possible; the analgesia extended over the same area as the previous day. An hour later, the condition of the animal being apparently normal, 15 minims were injected in the region of the bulb in the occipito-atloid space without puncturing the medulla. A few seconds later the animal became helpless; he could only advance by crouching on the ground with his paws in front of him, moving upon his sternum. He vomited. The analgesia involved the anterior part of the body, the head excepted. Two hours later he progressed more easily, and went to his kennel, where he ate his food. During the succeeding days and

for a month afterwards he showed nothing abnormal. Killed at the end of the month, no trace whatever could be found of the injections. All his organs were perfectly healthy.

These experiments—as yet not numerous, which the investigators intend to pursue—show, nevertheless, in a convincing manner that analgesia produced by cocaine injected into the neural canal is applicable in veterinary surgery, and that, with proper precautions, there is no danger. (It is worthy of note that not one of the subjects of experiment, not even those which had received manifestly too great a dose of cocaine, exhibited any abnormal respiratory or circulatory symptoms.) The doses used were fifteen to seventy-five minims of a 2 per cent. solution of cocaine for the horse or ox. For dogs fifteen minims should not be exceeded.

(*b*) Local Anæsthesia.

The dangers of general anæsthesia have stimulated the search for means of rendering insensitive the region of operation alone. Prolonged compression of tissues and mediate compression of the nervous trunks supplying the part are very imperfect methods. For a long time ice refrigerating mixtures and ether spray were exclusively used. Cocaine was afterwards discovered, and soon became popular.

Anæsthesia by Cold.—The prolonged action of cold renders superficial tissues bloodless and diminishes or even abolishes sensibility. Refrigerant mixtures have been used in operations like neurectomy.

Crushed **ice and salt**, mixed in the proportion of 2 to 1 are packed into a long bag and applied to the region of operation. In a few minutes, especially if the bag is pressed firmly into contact with the part, the skin becomes cold, firm, and insensitive, and incisions unless deep neither provoke pain nor hæmorrhage. The anæsthesia, however, is of short duration, and operation must be rapid.

By projecting an **ether spray** on the parts the temperature is soon so far reduced that trifling operations may be performed without pain. The action is rendered more rapid and complete by previously applying an Esmarch bandage. It is difficult, however, to render inflamed parts insensitive, and for this purpose refrigerating mixtures are preferable.

Bisulphide of carbon has no advantage over ether.

Methyl bichloride and anestile, successfully used in man for troublesome neuralgia, are almost too active, and though rendering the skin insensitive in a few seconds not infrequently freeze it, causing more or less extensive necrosis.

Local Anæsthesia by Cocaine.—**Cocaine** is almost insoluble in water, but the greater number of its salts dissolve freely. The most

frequently employed is hydrochloride of cocaine of 1 to 10 per cent. strength. The addition of a trifling amount of bichloride of mercury insures the solution keeping. Reclus recommends the following formula:

Hydrochloride of cocaine	1½ grains.
Sublimate	·03 grain.
Distilled water	2½ fluid drachms.

A few drops of this solution placed between the eyelids render the superficial layers of the cornea insensitive in three minutes.

By repeating the application at two-minute intervals the cornea, the conjunctiva, and eyelids are often completely insensitive in less than ten minutes, and anæsthesia lasts a quarter of an hour. The pupil dilates, but as a rule the iris is not rendered insensitive unless the injection is made into the anterior chamber. By this method puncture of the cornea and removal of foreign bodies fixed in the conjunctiva are rendered easy. Five or six subconjunctival injections made around the ball of the eye permit the eye itself to be removed without great pain. Cocaine acts equally well on other mucous surfaces, and under certain conditions may be useful in painful inflammations of these membranes. The most recent experiments appear to show, however, that the blanching and anæsthesia are followed by congestion of the parts, and the use of cocaine in gargles, etc., for inflamed pharynx has been abandoned in human surgery, the after effects being bad.

By a series of small injections along the course of a proposed incision operation is rendered painless, provided the seat of operation be in a mucous membrane or in the skin. A Pravaz's syringe fitted with a long fine needle is used, the needle being inserted into the subcutaneous connective tissue, or, better, into the thickness of the epidermis, following the direction of incision. As the needle is gradually withdrawn the piston is slowly pressed home, leaving the track filled with fluid. The anæsthetic qualities of cocaine are increased by previously injecting morphine.

Arloing states that cocaine has no effect on the nerve-cells, its action being confined solely to the terminal fibres of sensory nerves.

Its toxicity varies according to species. In the dog the dose varies from ¾ to 1½ grains. Strong solutions offer no advantages and are dangerous. Cocaine solutions of whatever strength, lose, more or less completely, their anæsthetic quality on becoming acid, but this can be restored by neutralising the liquid.

Local Anæsthesia by Infiltration.—Dr. Schleich produces local anæsthesia by causing artificial œdema in the region of operation. He performed amputation and even laparotomy successfully.

He showed that it is not necessary to inject strong solutions of the anæsthetics which might produce poisoning, but that quite weak solutions, even a ·2 per cent. solution of chloride of sodium, suffice, and that in all cases of anæsthesia, other factors than the mere chemical constitution of the substance play an important part. The injection of fluids under fairly high pressure into the skin and subcutaneous tissues renders the whole area affected completely insensitive. Should the tissues be cut through no blood flows.

This method produces anæsthesia by the co-operation of four factors—the pressure induced by the mechanical action of the liquid, cold due to the temperature of the solution, anæmia caused by the cold and pressure, and a chemical change produced in the nerve endings. The undermentioned formulæ, which have been used in human practice since 1894, have been lately used upon horses and dogs by Podkopajeu and Negri, who recommend them for their simplicity, harmlessness, and cheapness.

The condition lasts, however, for not longer than twenty minutes. Schleich's experiments showed that the best results attended the use of a combination of cocaine, sodium chloride, and morphine. He recommends the following formulæ for use in man:

Strong solution	Hydrochloride of cocaine	0·20
	Hydrochloride of morphine	0·02
	Chloride of sodium	0·20
	Water	100

7 fluid drachms injected at each operation.

Moderately strong solution	Hydrochloride of cocaine	0·10
	Hydrochloride of morphine	0·02
	Chloride of sodium	0·20
	Distilled water	100

14 fluid drachms injected at each operation.

Weak solution	Hydrochloride of cocaine	0·01
	Hydrochloride of morphine	0·005
	Chloride of sodium	0·20
	Distilled water	100

Use up to 140 fluid drachms at each operation.

He renders even the first prick of the needle painless by previously spraying the point of puncture with a mixture of four parts of sulphuric ether and one part of petroleum ether. Mucous membranes are rendered insensitive by dabbing with 10 per cent. carbolic solution, or with a solution of cocaine. The needle is slowly introduced into the skin itself in a direction parallel with the surface, and must not enter the subcutaneous tissue. As soon as the point has travelled a quarter to half an inch beyond the primary puncture the piston is gently pressed, causing a bleb to rise in the skin. The syringe is then slowly withdrawn, and again introduced within the periphery of the

little blister previously produced. This is quite painless, as the area has now become insensitive. A further blister is thus produced, and the operator proceeds in the same way until a chain of blisters is formed covering the entire length of the incision presently to be made. Each of these points of artificial œdema is anæsthetic. The method succeeds, not only in the case of skin and mucous membranes, but in serous and synovial membranes, muscles, nerves, and the periosteum. Even bones and the bone medulla can be rendered anæsthetic by subperiosteal injections. Deeper-lying tissues can, of course, only be rendered anæsthetic after the more superficial have been so treated. The condition persists for fifteen to twenty minutes; should an operation last longer the process must be repeated. In preparing for the insertion of sutures for instance, the needle of the syringe is passed from the cut surface towards the skin, so that the path which the suture needle will afterwards take is rendered œdematous. The bleeding from tissues thus rendered œdematous is remarkably slight; on incision the injection fluid is first of all discharged without admixture of blood, then little points of bright arterial blood appear in the fluid from the wound.

According to Schleich the injection of distilled water also induces local anæsthesia. A solution of ·2 per cent. chloride of sodium sets up local anæsthesia without previous hyperæsthesia; 3 per cent. solutions of sugar produce more or less pronounced anæsthesia. Pietro Ghisicui has experimentally studied at the Turin Veterinary School the results obtained by the above-mentioned formulæ, and by distilled and sterilised water.

The quantity of cocaine solution or of distilled and sterilised water employed varied; generally he used from $2\frac{1}{2}$ to 16 drachms of the strong solution, 3 fluid ounces of the moderately strong solution, $4\frac{1}{2}$ fluid ounces of the weak solution, instead of $1\frac{1}{2}$ to $4\frac{1}{2}$ fluid ounces of water. He noted a fleeting hyperæsthesia during the operation, the tissues became turgescent, infiltrated, œdematous, and anæmic. The œdema produced by the water and by the solution of Schleich disappears after eight or nine hours. The vitality of the tissues is unaltered, and cicatrisation takes place regularly. Complications, such as stupefaction, nervous or functional troubles, etc., have not been observed.

From twenty-two experiments made with water, and the same number with Schleich's solution, the author draws the following conclusions:

Anæsthesia by infiltration should be more common in veterinary practice. Schleich's method is very useful, practical, and cheap.

Solutions of cocaine may be replaced by distilled and sterilised water, with which complete local anæsthesia is obtained, lasting as long as that produced by Schleich's solution. In laparotomy water and cocaine solutions have an unsatisfactory effect, apparently due to the ready distension of the tissues, which prevents the requisite action of the fluids.

Bayer has tried Schleich's method in animals, and with such good results that he recommends it strongly, especially where difficulties exist in casting a horse. As an experiment, he made an incision about four inches long through the mucous membrane of the tongue and then sutured the wound. He also trephined the superior maxillary sinus without causing any apparent pain. The horse was operated on in the standing position, and was not restrained by twitches or other appliances. In another case, having cast but not chloroformed or twitched the horse, he divided the median nerve without causing any struggle. In this instance the nerve sheath was injected. At the point of operation the nerve was anæsthetic, but pressure with the point of the needle at any spot beyond the œdematous zone produced lively reaction. Möller successfully performed an extensive operation for hernia on a horse without casting. This method is particularly useful in dogs, which seem specially susceptible to the action of chloroform, and not infrequently die as a consequence of prolonged administration.

CHAPTER IV.

ANTISEPSIS AND ASEPSIS.

Although infection of wounds has always attracted the attention of the surgeon, he has until recently been ignorant of its nature, of its cause, and of the methods of avoiding it. During the first half of the last century infection of exposed wounds was attributed to impure and exhausted air, especially to the hospital atmosphere and to air charged with the miasma of putrefaction. The works of Pasteur and Tyndall seem to confirm the truth of this idea, by showing that it is not the air itself which has injurious properties, but only the germs it carries in suspension. Sterile organic fluids exposed to the atmosphere immediately begin to ferment, but provided they be kept from contact with all but optically pure air filtered through cotton wool they undergo no change. It was therefore concluded that decomposition and putrefaction are due to little animate bodies, suspended in the atmosphere,—*i. e.* germs or microbes—which under favourable conditions break down organic substances. Save for micro-organisms there would be no decomposition and no putrefaction. Extending the logical process, Lister was of opinion that the same process went on in injured tissues exposed to the action of air as occurred in organic liquids. Septic changes in wounds therefore represent a kind of fermentation.

The first important researches with the object of preventing such complications are relatively recent. In 1865 Lister, inspired by Pasteur's work on fermentation, began those experiments which eventuated in the formulation of his "antiseptic method;" while in 1870 Guérin, following up the same work and that of Tyndall, invented his surgical dressing.

Guérin applied to wounds the experimental conditions necessary for preserving organic materials from change when in contact with the air,

shielding the injured tissues by thick layers of cotton wool. Lister, on the other hand; sought to destroy microbes present in the wound or introduced during operation, by means of chemical substances. Lister first rendered the wound aseptic and afterwards protected it by a germicidal barrier.

Let us consider the surgical dressing. At first Guérin did not seek primary union of the wound, only attempting to reduce the discharges and to avoid infection. Bleeding having ceased, he washed the wound with tepid water, afterwards with a mixture of water and camphorated alcohol. In some cases he sutured the wound and cut the threads short, covering the parts with several layers of wadding. In extensive operations on the limbs the region was enveloped in many layers of wadding suitably affixed. The outer bandages were applied tightly, and if during the next few days the degree of compression was considered insufficient, or if the discharges penetrated the whole thickness of the wadding, fresh bandaging was resorted to. At first the dressing was left in position for twenty to twenty-five days, later it was replaced at the end of twelve to fifteen days. As a rule on removing the first dressing the wound was found to be granulating throughout. With a second dressing left in position for eight to ten days cicatrisation was complete.

To obtain primary union various modifications were made in this method. Thus bleeding was more thoroughly checked, and the lips of the wound carefully closed with deep sutures of some material like catgut, which would gradually disappear. Despite its many advantages this dressing of cotton wool concealed the state of the wound. The thermometer certainly gave indications of unfavourable changes, but as considerable fever sometimes occurs even when wounds are doing well, time was lost, and it was not infrequently necessary to remove the dressings, thus exposing the patient to danger. Further, although atmospheric germs could not enter the wound through the layers of cotton wool, those already there or introduced during operation were not destroyed, and frequently multiplied with great rapidity.

Compared with the older dressings that of cotton wool constituted an immense stride in the surgical art, but, nevertheless, its use did not become general. The greatest success was reserved for Lister's dressing, which was more practical and also more certain in its results.

To prevent infection Lister sought to destroy all infectious materials in and around the wound as well as in the neighbouring air. Completing this process, he took care that the hands of the surgeon and his assistants, the instruments, sponges, compresses, and all materials used

as dressings should be rendered thoroughly aseptic. The wound having been cleansed of organisms was covered with a material saturated with an antiseptic, and precautions taken to prevent accumulation within it of the serosity exuded by all injured tissues. Lister long preferred carbolic acid in solutions of 1 in 20 to 1 in 40. With the strong solution he disinfected the instruments, sponges, and seat of incision, and once the operation was over, the wound throughout. The weaker solution he used for disinfecting the hands of the surgeon and his assistants, and for washing out sponges during operation. To prevent the wound being infected by atmospheric germs he introduced an antiseptic spray, the vapour of which covered the entire area of operation. After operation and before the spray had ceased acting all bleeding was checked, vessels were ligatured with catgut, the threads were cut short, and the lips of the wound brought together with catgut sutures. Drainage-tubes were inserted to permit serosity, etc., to escape, and the dressing was then applied.

The region of operation was first covered with a strip of protective consisting of oiled silk, the object being to prevent prolonged action of the carbolic solution on the wound, as this proved too irritant. Over the protective was applied carbolised gauze, doubled six or eight times, the last two layers being separated by a layer of mackintosh to prevent the carbolic acid evaporating, and to force the wound discharges to traverse the entire thickness of the dressing before escaping. All these materials were fixed in place by bandages of carbolised gauze.

The action of the carbolic acid on the tissues produced an abundant discharge. At the end of twenty-four to twenty-eight hours, therefore, it was necessary to remove the dressing, examine the wound, the condition of the sutures and draining-tube, if necessary to remove the latter and replace them after thoroughly washing in strong carbolic solution, and to apply a new dressing, everything being done under the spray. Whenever pain or any marked elevation of temperature appeared to demand it, the wound was re-dressed with the same precautions. Such was the method for surgical wounds in tissues primarily free from infection.

For all recent accidental wounds with irregular margins the application of a dressing was preceded by a careful cleansing with 10 per cent. carbolic solution. Suppurating wounds received more complex preparation, being curetted and scrupulously cleansed with 10 per cent. chloride of zinc solution. As in them the irritant action of carbolic acid was not to be feared the protective was suppressed.

Lister's method of dressing rapidly spread throughout all Continental countries. Though it at once displaced the old methods, it possessed

some drawbacks, such as the minuteness of detail required, the time demanded for its application, its high price, and the dangers resulting from the poisonous nature of the antiseptic employed—carbolic acid. While, therefore, respecting the great principles laid down by the inventor, surgeons set to work to perfect and especially to simplify it. Carbolic acid was replaced by salicylic and thymic acids, by chloride of zinc, subnitrate of bismuth, corrosive sublimate, and iodoform. For carbolised gauze was substituted ordinary tarlatan preserved in dilute carbolic solution until the moment of use, or muslin kept for a week in strong carbolic solution. For drainage purposes tubes of decalcified bone were suggested, because they became absorbed, irritated the tissues little, and necessitated less frequent renewals of the dressing. The protective was shown to be useless, and drainage was suppressed except when immediate union appeared uncertain. The technique of dressing, the antiseptics, and the strength of solutions have been varied infinitely.

Believing that the principal point was to prevent atmospheric germs gaining access to the wound, Guérin paid less attention to disinfecting hands, instruments, and dressings, and his good results were in a large measure due to scrupulous observance of cleanliness, and to the habit he had formed of thoroughly washing the hands and cleansing the region of operation and its neighbourhood with soap and camphorated alcohol before operation.

Lister's method was more certain, but also had imperfections and shortcomings. The success which attended the introduction of antiseptics was certainly not due to carbolic acid alone. The antiseptic was credited with greater bactericidal powers than it possessed. The belief in its ability to rapidly and completely disinfect instruments, hands, and the region of operation was exaggerated. In Lister's, as in Guérin's practice, the most important factor was the rigorous cleanliness of the hands, of the instruments, and of the dressings. Antiseptic treatment of wounds might never have survived had not observance of cleanliness largely assisted it.

To protect wounds from the action of atmospheric germs was the chief preoccupation alike of Lister and of Guérin. Numerous observers, however, have shown that infection is almost always produced by the hands of the operator or his assistant; by the instruments, dressings, or liquids employed; not by atmospheric germs. Contrary to the belief generally held when antisepsis was introduced, entrance of air is little to be feared, and atmospheric germs, formerly regarded as so formidable, can almost be left out of account. Those which fall into a wound are generally destroyed by the phagocytes.

Those, however, introduced by insufficiently cleansed hands, instruments, and dressings are not only much more numerous but infinitely more dangerous. Septicæmia, once so common after hospital operations, was not due, as believed, to the introduction of atmospheric germs, but to organisms carried by dirty instruments, which had either undergone only a semblance of cleansing, or had even passed from the post-mortem room to the operating theatre!

The principal source of contamination being recognised, the disinfection of instruments, hands, and dressings received greatly increased attention. Bacteriological researches and some clinical investigations showed that disinfection by chemical agents is not always complete even when concentrated solutions are used. Organic substances, even in thin layers, are not always readily penetrated by liquid antiseptics, and the deeper strata may retain virulent organisms in spite of the prolonged action of such liquids. Chemical disinfectants are therefore reserved for the seat of operation, and the hands; instruments, ligatures, drainage-tubes, and other materials used for dressing are subjected to the action of boiling water, glycerine, heated oil, or simply to a high degree of dry heat. The simplest and most practical method is that of boiling in water, with or without the addition of sodium carbonate. Although it does not give absolute security—certain spores resisting even a temperature of 212° F.—it is almost always sufficient.

In hospital practice Chamberland's autoclave and dry heat stoves are very useful, the former being used for sterilising objects preserved in liquids where temperatures of 120° to 150° C. are required. Although during the last few years Continental surgeons have practised antisepsis in all its details and continued to perfect its technique, English and American surgeons are more and more abandoning the use of chemical bactericides and resorting almost entirely to the observance of rigorous cleanliness; in a word, they are abandoning antisepsis for asepsis. In veterinary surgery, however, the latter method will probably never obtain the same favour as the former. Strictly speaking, antisepsis and asepsis do not stand in opposition, but rather form mutual complements one of the other, aseptic methods being preventive, antiseptic curative; their association is often advantageous. Antisepsis is resorted to when the region of operation includes a suppurating wound, a fistula, or an ulcer, or when reunion by first intention has failed. Antiseptics are then employed to disinfect the seat of operation, the hands, the instruments, and the dressing materials. The aseptic method, on the other hand, is applicable to operations on infection-free tissues

which might become inflamed under the action of antiseptics, to limited cases of necrosis, and to intoxications; but if asepsis can be ensured, it is useless to apply to healthy tissues strong antiseptic solutions. Of the two principles—"antisepsis before and during," "antisepsis before, asepsis during"—the former is preferable in our practice on account of the chances of the wound, the hands, and the instruments becoming infected during operation. Even in human surgery, where, thanks to better surroundings and to special apparatus, rigorous asepsis can much more readily be obtained, and where the operator can count on highly skilled assistants, antisepsis, nevertheless, has its uses.

Among the organisms producing surgical infections two species, micrococci and bacilli, stand pre-eminent. Whilst the former are usually quickly killed by heat and the principal antiseptics, the latter resist to a varying degree, depending on whether they have attained the adult rod-like form or exist as spores. The adult bacilli are easily killed, the spores on the other hand are strongly resistent. Certain spores, like those of tetanus and septicæmia, exhibit most extraordinary vitality.

When dry, all microbes resist the action of heat and antiseptics to a higher degree and for a longer time than when moist. The most convenient method of destroying them is exposure to moist heat. Whilst steam at 212° F. kills the majority of pathogenic microbes, the dry temperature required for the same result varies from 290° to 330° F. Moisture considerably enhances the destructive action of high temperatures and of antiseptics. Few pathogenic microbes resist steam heat for more than a few minutes. Many die at 175°, 160°, and even 150° F., but the spores of tetanus and of some septic organisms endure higher temperatures than 212° F. without destruction. The following table shows the temperatures at which the organisms of chief surgical interest are destroyed:

Staphylococcus pyogenes aureus	is destroyed in ten minutes by a temperature of						137° F.
„	„ *albus*	„	„	„	„		144° F.
„	„ *citreus*	„	„	„	„		144° F.
Streptococcus of erysipelas		„	„	„	„		131° F.
„	strangles	„	„	„	„		140° F.
The bacillus of tetanus		„	„	„	„		167° F.
„ „	tuberculosis	„	„	„	„		167° F.
„ „	glanders	„	„	„	„		131° F.
Anthrax spores	are destroyed in ten minutes by a temperature of						212° F.
Tetanus spores	„	„	„	„			220° F.
Septicæmia spores	„	„	„	„			247° F.

Tetanus spores are destroyed in fifteen minutes by a temperature of 212° F. and in five minutes by a temperature of 240° F. At ordinary

temperatures they resist 5 per cent. carbolic solution for more than ten hours. The septicæmia organism resists 212° F. for a quarter of an hour. In a dry state it is destroyed in ten minutes by a temperature of 250° F. The organism of black-quarter is destroyed in ten minutes by immersion in boiling water. When dry it resists a temperature of 250° F. for ten minutes. Moist anthrax spores are destroyed in a few minutes by a temperature of 212° to 220° F. When dry they are only killed after ten minutes' exposure to a temperature of 240° F.

Antiseptics.

Carbolic acid is used in solutions of 1, 2, or 5 per cent. strength. The 5 per cent. is for disinfecting the instruments, seat of operation, abscess cavities, suppurating wounds, and sometimes for exciting slight adhesive inflammation when inserting intestinal sutures. It is unsuitable for operation and recent wounds, because it strongly irritates the tissues and produces free serous exudation, thus impeding immediate union. The 2 per cent. solution is suitable for irrigating fresh wounds, for disinfecting the hands, and for rinsing out the wound during operation. The 1 per cent. solution is used for disinfecting certain mucous surfaces and for obstetrical operations.

Sublimate or bichloride of mercury solution is one of the most useful chemical antiseptics. Koch states that a 1 in 1000 solution destroys bacteria and most micro-organisms in a few minutes. On account of its toxic character many surgeons restrict its use to the disinfection of the skin and vaginal mucous membrane. For other mucous surfaces and for deep wounds they regard it as dangerous. Nevertheless, in weak solution it is valuable for irrigating surgical and accidental wounds, as it irritates tissues less than carbolic acid. It blackens metallic instruments, destroys their polish, and injures their edge. For obstetrical operations it is sometimes replaced by biniodide of mercury. The strong solution of sublimate is prepared as follows:

Sublimate . . .	1 part.
Tartaric acid . . .	5 parts.
Boiled water . . .	1000 ,,

The weak solution contains double the above quantity of water. Solutions of 1 in 3000 to 1 in 5000 can be used for most mucous membranes. As, however, it is decomposed by alkaline salts, distilled water must be used for making solutions, or a small quantity of acetic or salicylic acid added to ordinary water before use. To prevent sublimate solutions being decomposed by contact with albumen, five

parts of chloride of sodium or ammonium to each part of sublimate are added in preparing them. A convenient method of preparing sublimate solutions is offered by the tabloids, etc., manufactured by various wholesale chemists. An excellent material for disinfecting the surgeon's hands is obtained by dissolving two parts of sublimate in 1000 parts of rectified spirit. Frick's wound gelatine for covering wounds after operation is prepared by soaking gelatine in 1 in 1000 sublimate solution, dissolving by heat, and adding 10 per cent. glycerine. It adheres better than collodion.

Chloride of zinc, formerly used for treating unhealthy wounds, is a powerful antiseptic. In 5 per cent. solution it rapidly destroys most spores (Koch), but it is caustic. The 10 per cent. solution is useful for disinfecting fistulæ, abscesses, and suppurating or septic wounds.

Socin's paste, consisting of 50 parts oxide of zinc, 50 parts water, and 5 parts chloride of zinc, is used in veterinary practice; applied to aseptic sutured wounds it forms a kind of protective varnish, replacing a dressing. It is specially useful for wounds about the head and in the upper regions of the body.

Permanganate of potash is also a good antiseptic, devoid of toxic properties. It owes its microbicidal powers to the oxygen which it disengages. Producing no irritation it can be used for all wounds, especially those in mucous membranes. A strength of 1 in 1000 is useful for disinfecting the mouth, nasal cavity, vagina, rectum, and serous cavities. A 10 per cent. solution is used for infected wounds, and occasionally for the hands. The stain can be removed by plunging the hands into a 10 per cent. solution of bisulphite of soda to which has been added a few drops of hydrochloric acid.

Biniodide of mercury is stated to be thirty times more active than sublimate, and of a strength of 1 in 10,000 to 1 in 20,000 is used for disinfecting the vagina and mucous membrane of the uterus. This solution neither irritates the hands nor the lips of wounds, and does not injure instruments.

Iodoform, long used for treating wounds and ulcers, is especially useful in checking suppuration. Its action is slow. Being both antiseptic and analgesic it assists cicatrisation, retards decomposition of wound discharges, and diminishes pain. Powdered over the lips of wounds before suturing it does not prevent immediate union. Dusted in a thin layer into wounds with loss of substance it keeps them aseptic for 5, 6, or 7 days, constituting a kind of disinfecting reserve. Used freely and over large areas it may, in recent wounds, become dissolved in the fatty materials often contained in the serous exudate, giving rise to intoxication. Its disadvantages are its

disagreeable odour and high price. Three preparations of iodoform are used in surgery, viz. saturated solution in ether, a 10 per cent. emulsion in glycerine, and a 10 to 20 per cent. ointment in vaseline. The glycerine emulsion is useful in the treatment of abscesses, tuberculous cavities, and contused wounds, like those caused by carriage poles, etc. Gauze and wadding impregnated with iodoform are largely used as antiseptic dressings. They contain 10, 20, and 30 per cent. of iodoform. Iodoform wadding is used to fill the cavities of wounds, and in dressings applied after operation on the vagina.

Di-odoform contains 95 per cent. of iodine, whilst iodoform contains only 69 per cent. It is a yellow material, insoluble in water, slightly soluble in alcohol, but very soluble in most hydrocarbons. It keeps well in darkness, is very sensitive to the action of light, and is without odour. It is one of the most active promoters of healing known, though of very slight microbicide power.

Salol contains about 40 per cent. of carbolic acid, occurs in powder form, like iodoform, and has the advantage of possessing no smell. It is sometimes used for preparing gauze and wadding.

Cresyl or **creolin** is very widely used as an antiseptic in veterinary surgery. Being miscible in all proportions with water, alcohol, and glycerine, very slightly toxic, and not attacking either the operator's instruments or hands, it is largely employed. A 3 to 5 per cent. solution is used for disinfecting instruments, infected wounds, and the skin before operation, A 1 per cent. solution is prepared for disinfecting deep wounds, mucous membranes, the uterus, etc. It has, however, the drawback of rendering instruments slippery, and its milky solution prevents their being seen. A 10 per cent. alcoholic solution and a 10 per cent. ointment prepared with vaseline are largely used.

Formalin consists of a 40 per cent. aqueous solution of formaldehyde. Diluted with four to five hundred parts of water, it becomes a useful disinfectant for the hands, seat of operation, and accidental wounds. Strong solutions are irritant and caustic. Tannoform, glutol and amyloform are compounds of formaldehyde with tannic acid, gelatine, and starch respectively. They form useful dry dressings for open wounds, but are of greatest service when preceded by the application of a liquid disinfectant.

Chinosol is a yellow, crystalline powder, derived from coal tar. A solution of one part in forty thousand prevents bacterial development, and a grain dissolved in six drachms of water is said to be equal in antiseptic power to a 2½ per cent. solution of carbolic acid. Solutions for surgical purposes vary in strength between 1 in 1200 and 1 in 60.

Combined with starch or French chalk chinosol forms an efficient dry dressing.

Nitrate of silver of a strength of 1 to 2 percent., or of 1 per 1000, is used with success for disinfecting certain inflamed mucous membranes.

Boric acid is little used in solution, but as a dry powder is widely employed for dressing wounds after operation. Its irritant properties are slight, and being non-volatile its action is long continued. A saturated solution is of great value for operations on the eye, and for disinfecting the mucous membranes of the buccal and nasal cavities, the rectum, vagina, and bladder.

Naphthol of a strength of 1 in 1000 is a feeble antiseptic. Naphthalin has the same properties as naphthol, exercises a stimulating action on the tissues, and promotes granulation of wounds. Camphorated naphthol is a yellowish-brown, syrupy liquid, produced by triturating one part of naphthol with two parts of camphor. Camphorated salol is an opalescent liquid, produced by warming together equal parts salol and powdered camphor. Camphorated thymol is an almost limpid fluid, produced by triturating one part of thymol with two parts of camphor. These three products are used in treating suppurating wounds.

Sterilised salt solution consists of boiled water containing six to seven grammes of chloride of sodium per litre, and is very useful in washing out the abdominal cavity during or after operation.

The number of antiseptics increases every day, but the more recent have no marked superiority over those mentioned. Carbolic acid, sublimate, chloride of zinc, and iodoform still maintain their position.

Antisepsis and Asepsis in Practice.

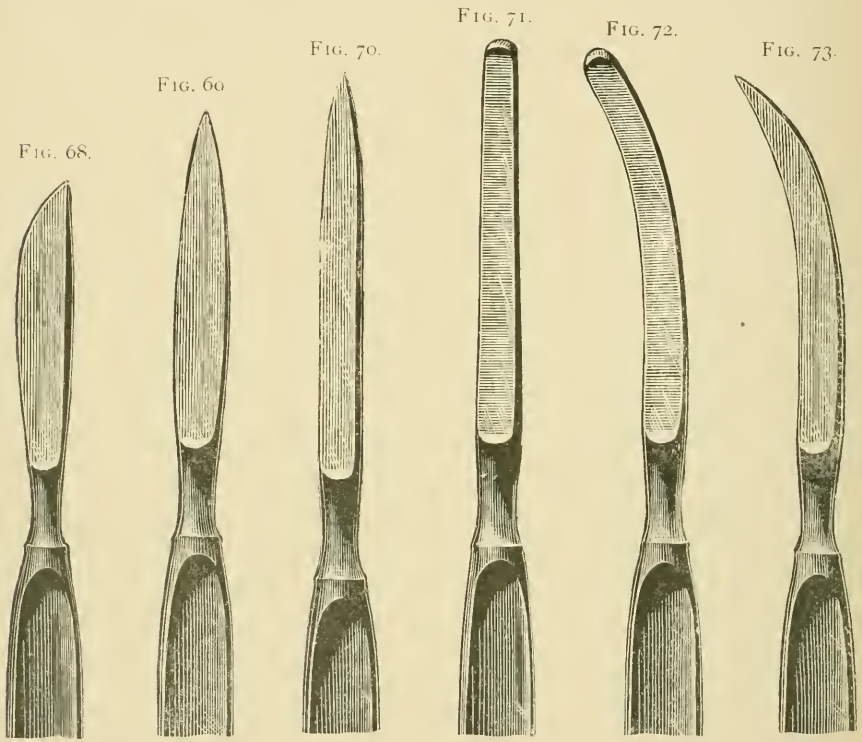
We shall now consider what antiseptics are best suited for disinfecting the hands of the surgeon and his assistants, the instruments, dressings, and field of operation, and how they can best be employed.

Disinfection of the Hands.—Fürbringer's experiments have shown how difficult it is to render the hands aseptic. The matter is, however, of the highest importance, as the operator's hands are not infrequently the means of infecting operation wounds, and the surgeon who desires to avoid after-complications will take especial care in this respect. The spaces beneath the nails, the folds of skin at their base, the folds of the skin itself, and the orifices of skin-glands are all refuges for microbes, to destroy which demands the most minute precaution. In some cases it is impossible to render the hands completely aseptic. Kümmel and others have shown that after soiling with pus or with putrid or septic liquids from infected wounds or dead bodies, it is

impossible to render the hands absolutely sterile for forty-eight hours. The surgeon should bear this in mind when operating in regions like the peritoneal cavity, and in performing laparotomy, ovariotomy, or cryptorchid operations. He should either defer operation for some days or redouble his precautions; neglect in this respect explains failure where apparently all the conditions for success have been present. The nails should first be cut short, and all foreign material mechanically removed from under and around them. The hands and forearms should next be washed for some minutes with soap and warm water, and scrubbed thoroughly with a brush or a Turkish flesh glove. They are then washed with rectified spirit, and lastly with 1 in 1000 solution of sublimate. The alcohol dissolves fatty materials which would otherwise impede the action of the antiseptic, and enables the latter to penetrate some distance into sebaceous ducts, etc. More complex methods have been suggested, but the above is sufficient. In veterinary surgery the precautions usually taken only extend to thoroughly cleansing nails, washing the hands with hot water and soap, and thoroughly rubbing them for some minutes with 1 in 1000 sublimate solution or 3 per cent. solution of creolin. The hands must be rendered aseptic and kept aseptic throughout the operation. For this reason the operator should avoid touching the skin surrounding the point of operation, the table, the straw or any object which has not been disinfected. Even when nothing suspicious has been touched, it is well during operation to plunge the hands from time to time in a disinfectant; should the hands actually have been soiled, they must immediately be cleansed again. The precaution must be rigorously observed during operations in the peritoneal cavity, where an act of forgetfulness may entail the patient's death. During operation the surgeon and all his immediate assistants should wear linen operating coats which can readily be washed.

Disinfection of Instruments.—The handles of modern instruments are generally made of German silver, nickel, or aluminium. They should present no unnecessary ornamentation, depressions, grooves, corrugations, or spots likely to hold dirt. Instruments like scissors, forceps, etc., should be capable of disarticulation for cleansing purposes, and complicated instruments difficult to clean should be discarded. Wherever possible instruments should be in one piece, like the retractors in Figs. 75, 76, and 77; for more complicated instruments the French joint, as shown in the lion forceps, Figs. 78 and 79, is the best. For sutures, Larger's or Mooij's needles are preferable to others, being simple and readily sterilised. For syringes with pistons one can often substitute a simple glass tube carrying a rubber ball, the

piston being then replaced by a column of air. Many methods and materials for rendering instruments aseptic have been recommended. Immersion in carbolic or creolin solution is advised by many surgeons, but carbolic solution attacks the cutting edge of bistouries, and creolin



Figs. 68—73.—Scalpels.

renders instruments slippery, while the opacity of the emulsion prevents instruments being distinguishable one from another. Immersion in boiling water is a simple and practical method. The boiling-point is

Fig. 74.—Dissecting forceps.

raised by the addition of common salt, carbonate of soda, carbonate of potash, or chloride of calcium, and any detrimental effect on metallic instruments can be prevented by adding 1 per cent. of caustic soda. Where a higher temperature of 250° to 260° F. is required the bath may

be of oil, glycerine, or melted vaseline. When instruments have been soiled with a particularly virulent discharge, like that of tetanus, septicæmia, etc., the best method is to immerse them for ten minutes to a quarter of an hour in the oil or glycerine bath. Otherwise prolonged boiling in ordinary water or carbonate of soda solution is sufficient. The vessel in which this boiling takes place should be provided with a tight lid, so that after boiling the whole may be placed on one side to cool. Immediately before operation the instru-

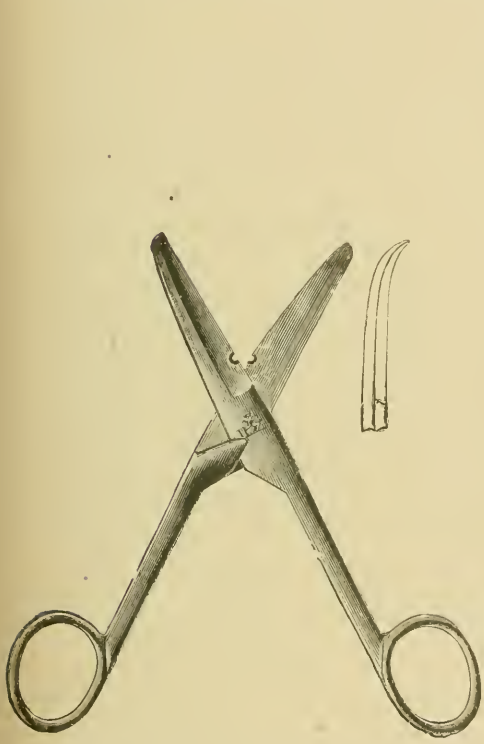


FIG. 75.—Curved scissors with German aseptic joint.

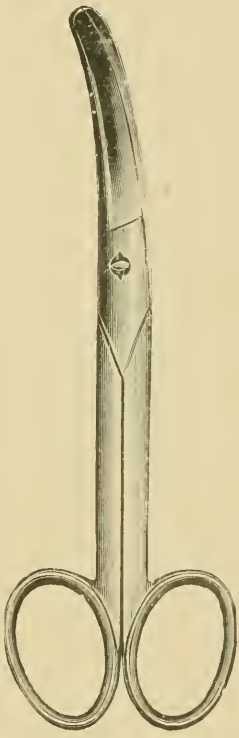


FIG. 76.—Curved scissors with French aseptic joint.

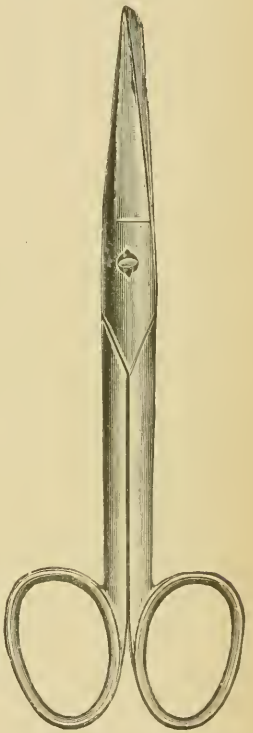


FIG. 77.—Straight scissors with French aseptic joint.

ments are removed from it, and placed in trays containing an antiseptic solution (3 per cent. carbolic), in which they remain until required for use. Should the operator have finished with an instrument for the moment it should be immediately returned to the solution, and never allowed to come in contact with the straw or be laid on the animal's body. Trays of glass or porcelain are very useful, though vulcanite is also largely employed, being much less brittle. All vessels of the kind must be subjected to a thorough cleansing before use. As the wooden handles of instruments are injured by boiling, the handle

should be thoroughly cleansed and the blade alone disinfected in boiling water.

Autoclaves, steamers, or stoves are only used in the laboratory or in hospital practice.

Disinfection with burning alcohol is another rapid method of disinfecting instruments. The instruments are placed on a metallic plate previously rinsed with a little alcohol, which is then ignited.

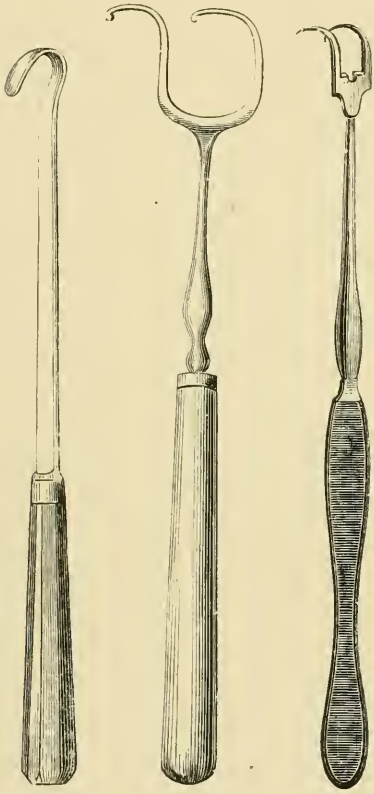
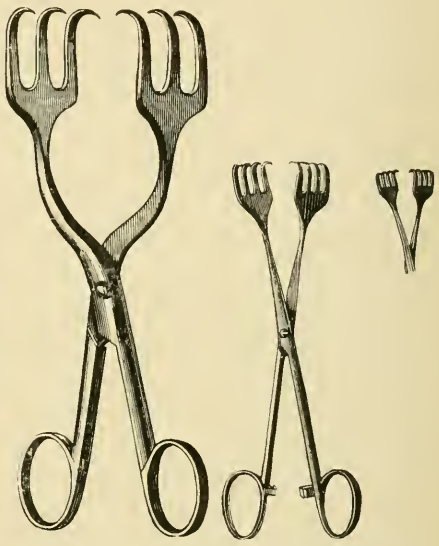


Fig. 78. Fig. 79. Fig. 80.
Retractors with metal handles for aseptic surgery.



Figs. 81, 82.—Lion forceps, with French aseptic joint for cleansing and sterilising.

A few minutes suffice to render them sterile, when they can be placed in a weak antiseptic solution or in boiled water. Although excellent for ecraseurs, forceps, directors, etc., this method is apt to damage the temper of bistouries, scalpels, and scissors.

Gum-elastic probes are washed in strong alcohol and afterwards in 1 per 1000 sublimate solution.

In addition to instruments the surgeon employs sponges, tampons, cotton or tow compresses, suture threads, and various dressing materials. All such materials should previously have been rendered aseptic. After having been beaten with a wooden mallet, the sponges are washed in running water, placed for ten to twelve hours in a 1 in

1000 solution of permanganate of potash, washed in boiled water, and afterwards placed in strong carbolic solution, where they should remain for at least two to three weeks before use. Immediately before use they are washed in boiled water, to remove the excess of carbolic with which they are saturated. At the present time sponges have generally been given up, and compresses of gauze or sponge tissue sterilised in the autoclave, and tampons of absorbent wool or turf tissue are preferred. Many veterinary surgeons still use tow. This is unsuitable unless it has been thoroughly cleansed and sterilised by heat or by immersion in a boiling antiseptic solution. When used the method generally adopted is to plunge the tow for five minutes into boiling water or into a boiling soda solution.

FIG. 83.—Steam steriliser for instruments (packed for transport).

Silk thread is sterilised by immersion for half an hour in boiling water, or by exposure to a temperature of 220° to 230° F. in the autoclave. Immersion for a quarter of an hour in strong carbolic solution is also sufficient. It is preserved in glass holders (see Figs. 85—88) in 5 per cent. carbolic solution, or in 1 in 1000 sublimate solution.

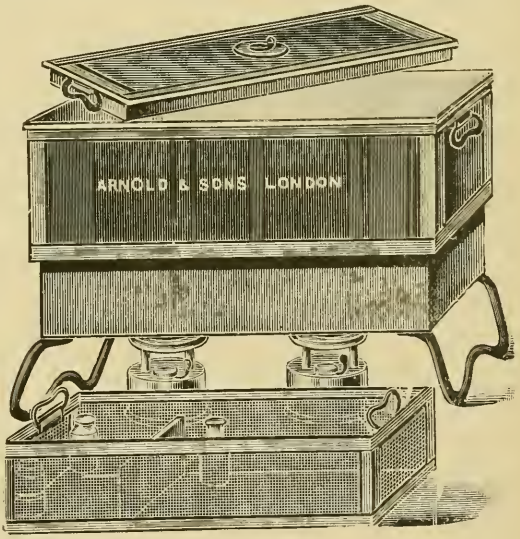


FIG. 84.—Steam steriliser for instruments (open in use).

Catgut is deprived of adherent fat by immersion in ether, and after drying is wound on bobbins. These can be sterilised by dry heat, and preserved in a strong sublimate or carbolic solution or in boiled olive oil.

Silkworm ligature is treated with ether boiled for half an hour in water, and then placed in tubes containing 2 per 1000 solution of sublimate.

Paraffined thread is prepared by immersing hemp thread, previously saturated with ether or oil of turpentine, in melted paraffin. To remove any stiffness it may be passed through a cloth before use

This thread is flexible, does not absorb organic liquids, nor cut out rapidly. It is, therefore, especially useful for sutures intended to remain long in position.

Drainage-tubes are preferably formed of red rubber. After thorough washing in concentrated permanganate of potash solution they are left for twenty minutes in boiling water, transferred to tubes containing 2 per 1000 solution of sublimate, and finally sterilised by exposure to a temperature of 120° for half an hour. They are sometimes replaced by bundles of stout antiseptic silk or catgut, along which drainage proceeds, or by slips of antiseptic gauze.

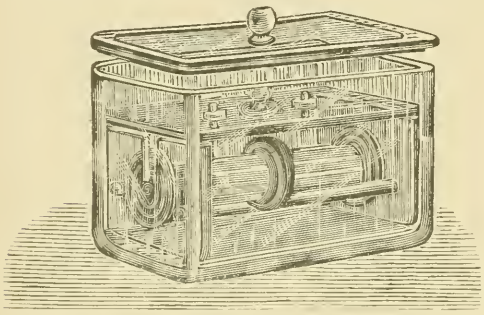


FIG. 85.—Silk-holder for hospital use.

The above methods of procedure for sterilising compresses, suture materials, and drainage-tubes are not absolutely indispensable. The method usually employed in veterinary surgery is to immerse them for five to ten minutes in strong boiling carbolic, creolin, or sublimate solutions. Bang considers this sufficient.

The field of operation and surrounding parts must be most carefully cleansed. In all animals the skin is covered with extremely numerous and varied micro-organisms, among which the *Staphylococcus albus* and *aureus* are particularly abundant. It is, therefore, always important to disinfect the parts. If the skin is healthy, the hair is clipped away with scissors or removed with a clipping machine, the parts thoroughly soaped, shaved, scrubbed, and washed with boiled water. After being dried with a sterilised compress, the parts are rubbed with alcohol or ether to remove fatty materials from the surface, and are finally washed with strong carbolic, or 1 in 1000 sublimate solution. If the skin is infected, or the seat of an ulcer, suppurating wound, or fistula, it is necessary, the day before operating, or even some days in advance, to curette the wound, afterwards proceeding as just indicated. In abdominal operations, exposing the peritoneum, special care must be taken in shaving and disinfecting a wide area, while the operative area should

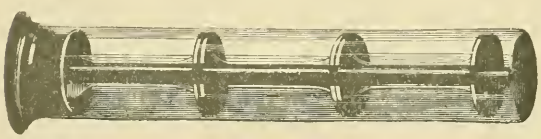


FIG. 86.—Portable silk-holder.

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be covered with towels recently boiled or soaked in an effective disinfectant. Convenient irrigators for holding the above disinfectant solutions are shown in Figs. 90 and 91.

These two principal methods, however, are not applicable to all surfaces. They may require modification in certain regions. In all mucous membranes it is necessary to remove the mucus from the surface by freely washing with boiled water in order to permit antiseptic solutions to act more freely.

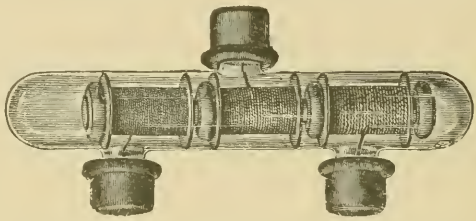

FIG. 87.—Sterilised silk in portable sealed tubes.

The mouth is always infected with micro-organisms, and is difficult to disinfect. In large animals disinfection is confined to washing freely with water followed by 2 to 4 per cent. solutions of boric acid, 1 in 1000 of permanganate of potash, or 1 per cent. of chloral. In the dog decayed teeth should be removed, and, if necessary, the gums swabbed with tincture of iodine or creolin solution.

To promote intestinal antisepsis previous to intra-peritoneal operation, the bowel should be emptied by a smart purge, the animal placed on a reduced or milk diet, while antiseptic substances can be

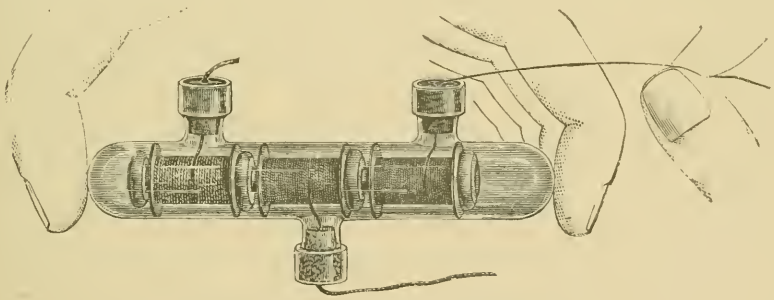

FIG. 88.—Showing method of withdrawing silk.

administered by the mouth. Saline purgatives in small repeated doses are valuable as a preparation, after which naphthol, betol, or creolin may be given in the proportion of 50 centigrammes to 1 gramme for small animals, and 5 to 10 grammes for the horse and ox. Rectal injections of a solution of 1 in 1000 permanganate of potash, 1 to 2 per cent. creolin, 1 to 2000 sublimate, or 4 per cent. boric acid, complete the preparation. When, during operation, the bowel is divided, the ends withdrawn from the peritoneal cavity are kept closed by clamps

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or by pressure with warm sterilised compresses, care being taken to avoid soiling the peritoneum by material escaping from the incision; the bowel must not be returned until it is certain that the wound has been completely closed and the serous coats around the suture touched with a strong carbolic solution in order to produce a slight adhesive inflammation. For eight to ten days after operation only small quantities of liquid nourishment, such as milk and beef-tea for small animals and hay-tea for others, should be given. Ordinary food is then gradually resumed.

In disinfecting the rectum, the food is diminished for several days in advance, and the same materials are prescribed as for intestinal antisepsis. In addition, however, the rectum must be frequently irrigated. The anus is disinfected in precisely the same way as the healthy skin.

Fig. 89.—Drainage tubes in sublimate or carbolic solution.

The nasal cavities can be rendered aseptic by washing out with sterilised lukewarm water, and afterwards by injecting a 1 in 5000 solution of sublimate or a 1 in 1000 solution of permanganate of potash.

The eye demands special precautions. It can be bathed with sterilised water, 4 per cent. boric solution, 1 in 150 or 200 creolin solution, or the following solution of biniodide of mercury recommended for man by Panas:

Biniodide of mercury .	5 to 10 centigrammes.
Absolute alcohol . .	20 grammes.
Boiled filtered water .	1000 grammes.

Sublimate must also be greatly diluted (1 in 5000). The instruments must be perfectly sterilised, especially if the globe of the eye is to be opened.

Disinfection of the external auditory meatus is carried out with weak antiseptic solutions. The skin is cleansed with warm water and soap, dried, and irrigated with 3 to 4 per cent. boric acid solution, 1 in 1000 permanganate of potash, or 1 in 5000 sublimate solution. If discharge is abundant, the use of bismuth, salol, or iodoform is indicated.

Antisepsis of the vagina is usually easy. Soap solution is used for cleansing the mucous membrane, which is afterwards irrigated with 4 per cent. boric, 2 per cent. creolin, or 1 in 2000 sublimate solution. These irrigations are repeated on several successive days. Instead of syringes, irrigators consisting of a glass reservoir and an india-rubber tube can be used. It is difficult however, to disinfect the

vagina when the mucous membrane is the seat of polypi, ulcerating tumours, or when it has been infected during removal of a putrid fœtus.

The uterus is disinfected in the same way as the vagina, a long india-rubber tube being employed.

Beyond passing the catheter few operations are performed on the bladder. In this case preventive treatment is of the greatest importance. Until now the dangers of catheterisation, as usually practised, have not received sufficient attention. Acute cystitis and its various complications may follow the introduction of soiled catheters, which are cleansed with difficulty and are more or less septic.

Catheters should be disinfected by prolonged immersion in strong antiseptic solutions, and afterwards be kept in a special case.

In operations on the foot, local antisepsis is ensured by the following method :—The shoe is removed, the plantar surface of the hoof thinned, the hair clipped away from the whole limb up to the knee, the hoof thoroughly brushed with hot water and soap, freely washed with an antiseptic solution, in which it should be immersed for a quarter of an hour to twenty minutes, then enveloped in compresses saturated with an antiseptic, and fixed in position by means of tarlatan bandages. Linseed poultices prepared with a strong disinfectant solution certainly soften the horn, and may be useful, but from the point of view of antisepsis the superiority of compresses cannot be gainsaid.

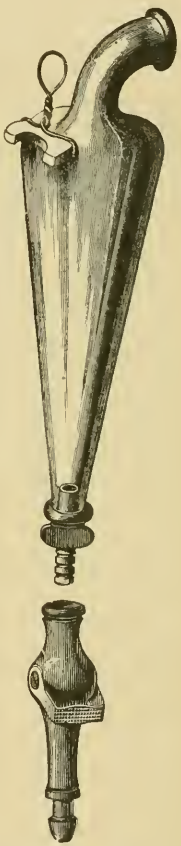

Fig. 90.—Irrigator for hospital use; for hanging on wall.

Before commencing operation, the ligatures, suture and dressing materials should be placed in a sterilised dish. Two other dishes or plates containing an antiseptic solution are provided for the instruments and cotton wool tampons used for absorbing blood. Immediately the skin is incised blood flows, becoming more abundant as the incision extends, and concealing the point of operation. This hæmorrhage is from small vessels, and can be checked by constantly mopping the parts with tampons of cotton wool taken from the antiseptic solution. Carbolic solution checks bleeding, causing the tissues to contract and bleeding vessels to close, but it has the

disadvantage of producing superficial necrosis. Provided there is no infection, simple boiled water, or water containing a little common salt, is sufficient. When arterioles or small veins are cut, they can be picked up with forceps and ligatured with silk or catgut. In most inflamed tissues hæmorrhage is abundant, even when no large vessel has been cut. In such case the thermo-cautery is sometimes useful; by passing it at a red heat lightly over the lips of the wound bleeding is checked. The thin aseptic scar thus produced does not necessarily prevent union by primary intention, as it may be completely absorbed. The same is true of ligatures left in wounds. Catgut is digested by the tissues, or destroyed in a few days by large migrating cells, and by the new cell elements; silk becomes encysted and is slowly absorbed.

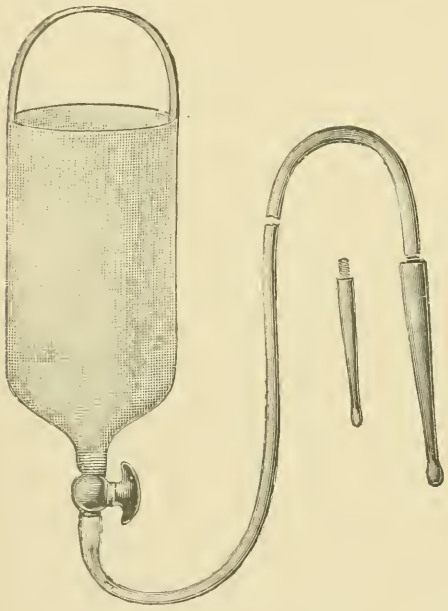

Fig. 91.—Portable irrigator.

To obtain primary union, the wound must be scrupulously guarded against infection. All bleeding must be stopped, and the tissues brought exactly into apposition. A thin layer of blood in an aseptic condition between the lips of the wound does not prevent primary union; the tissues tolerate it, and it is even utilised in the process of repair: but large clots are absorbed with difficulty, and present a very favourable soil for the growth of pathogenic microbes. The bleeding surfaces are dried as far as possible, covered with antiseptic vaseline [vaseline 50, powdered boric acid 5, iodoform 1], closely approximated throughout their extent, *i. e.* both superficially and deeply, and every effort made to secure contact. When coaptation is not perfect in the depth of the wound, a space is left for the accumulation of blood and serosity, in which any retained germs multiply rapidly. Where the wound implicates several different layers, it may become necessary, in order to keep these closely in apposition, to pass a number of deep sutures of catgut or silk fixed at their extremities to little rolls of gauze [deep or anti-tension sutures], in addition to inserting superficial sutures of silk or silkworm ligature. Lastly, the surface is washed with sublimate

solution, dried with tampons of absorbent wool, and covered with a film of iodoform collodion, or with a dressing of surgical wool.

When it is impossible to bring the surfaces of the wound perfectly together, or when there has been much loss of substance, provision must be made to prevent the accumulation of discharges by inserting one or more rubber drainage-tubes, a carefully disinfected plaited horsehair tape, a strand of plaited silkworm ligatures, or a strip of gauze. Rubber drainage-tubes are generally employed. They can be fixed to the lips of the wound by a silk or silkworm-gut suture. Their presence allows antiseptic injections to be made into the bottom of the wound without touching the sutures.

The above are the measures required to absolutely prevent infection of operative wounds. Minutiæ and superfluous details have been omitted. Most human hospitals contain highly complicated installations for absolutely ensuring success, permitting the operator to obtain union by primary intention, and to avoid bad consequences even after prolonged manipulation within the abdominal cavity. Almost all the veterinary schools of Europe similarly contain operating theatres provided with installations and material for facilitating the practice of asepsis and antisepsis.

It is not indispensable rigorously to follow this technique in every case to obtain good results. Even in human operations performed outside hospitals or special nursing institutions the surgeon is able to insure a sufficient antisepsis without such complicated measures. Dégive, who published a series of one hundred castrations of cryptorchids without a single casualty, certainly did not conform in every respect to the rules of antisepsis. Although very important when operating in a contaminated area like the atmosphere of a hospital, such rules can be partly neglected in operations practised under more favourable circumstances, in either town or country. Even without such an array of instruments, vessels, antiseptics, and dressing materials, asepsis can be so nearly secured as to ensure good results. Moreover many operations must be performed on the spot, and with the means at hand, if the patient is to be saved. In such cases one operates under a shed or in the open air. To prevent dust produced by the animal's struggles soiling the seat of operation, the bed may be slightly moistened. Two large dishes contain respectively a strong solution of common salt and boiled water. The seat of operation having been denuded of hair, either with a clipping machine or by shaving, is thoroughly scrubbed with soap and water by means of a nail-brush, and

then rinsed with boiled salt water. The surgeon, after having thoroughly cleansed his nails, washes his hands and forearms in the salt solution. A basin in which a little alcohol has been ignited is filled with boiled water for the purpose of cleansing the hands during operation. The instruments can be disinfected by passing them through the flame of an alcohol lamp, or by moistening them with alcohol which is afterwards ignited, or even by immersing them for five or ten minutes in a boiling 1 per cent. solution of carbonate of soda, *i. e.* ordinary washing soda. To disinfect cloths, tampons for cleansing the wound, suture material, and tow, boiling salt solution can be used.

The seat of operation is protected by a "dressing" formed of layers of surgical wadding or tow, suitably arranged and fixed in position by bandages (*see* Chapter on "Bandaging and Dressing"). Dressings applied to the upper regions of a limb should either be comparatively loose or should extend to all the parts below, in order to avoid interference with circulation and such consequences as swelling and sloughing.

The first dressing is exceedingly important. Very often it determines the entire after-course of the wound. It can be left in place for a varying time. If the patient's general condition is good, and the fever is slight, and if the dressing remains dry, it need not be renewed for twelve to fifteen days in winter, and from eight to ten days in summer. If, during removal, the deep layers of wadding adhere to the skin, they should be moistened and softened with a warm antiseptic solution, or in the case of the foot by placing the extremity in a bucket containing the liquid. The skin should be carefully cleansed with tampons of cotton wool.

Where primary union has occurred the wound is found cicatrised on removal of the first dressing: if, however, it is only progressing favourably, nothing more is needed than the application of a fresh dressing, the same precautions being observed as on the first occasion. Care must be taken to avoid disturbing the wound or moving the lips; drainage-tubes can be replaced after disinfection, fresh ones of similar calibre but of shorter length can be substituted, or drainage-tubes may altogether be discontinued. When the wound is suppurating the sutures must be cut, the drainage-tubes removed, and the whole cavity freely washed out, avoiding injury to granulating surfaces. A new dressing, with or without drainage, may be applied, or the wound may be left open and treated with antiseptic liquids or powders. The latter absorb wound discharges, check the growth of germs on the surface, and diminish the absorption of toxic products.

Special precautions are required to combat such local complications as abscess formation, burrowing of pus, phlebitis, lymphangitis, necrosis or caries. This is not the place for considering them. We need only say that prolonged immersion in warm antiseptic solutions produces remarkably good results in infected wounds of the extremities, and that spraying with similar solutions is an excellent method of disinfecting cavities in regions to which continuous irrigation is inapplicable.

Speaking generally in veterinary practice, preference should be given to such methods as are simple and relatively cheap, but expense should be regarded as of secondary importance when dealing with penetrating wounds of the thorax, abdomen, articulations, tendon-sheaths, and with injuries to tendons, cartilages, and bones. It then becomes the duty of the veterinary surgeon to prevent, by every means in his power, grave infectious complications resulting from such wounds. The unfavourable conditions under which he habitually works, and the intractability of most of his patients, render primary union of operative wounds in the greater number of cases uncertain. Although in the country it is unnecessary to practise asepsis and antisepsis as rigorously as in a great human hospital, it would be the less excusable to entirely neglect such principles, inasmuch as we know very well the grave consequences which may follow. If unable to satisfy all the demands of the antiseptic system, we should at least observe its broad principles.

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CHAPTER V.

DIVISION OF TISSUES.

Cutting and Puncturing Instruments.—The first method of dividing soft tissues is by means of cutting instruments like knives or scissors.

Knives are of varying form and size: those in which the blade and handle are immoveable are termed scalpels; those in which the blade is protected with scales and turns on a hinge, bistouries.

Knives, again, may be divided into sharp-pointed and guarded or probe-pointed; either of these may be straight, convex, or concave.

Scissors are either sharp or round pointed, and flat or curved in the blades (*see* Figs. 75, 76, and 77, p. 83).

In making primary incisions a knife with a convex cutting edge is usually employed, and is grasped after the manner of a table knife (Fig. 92). In making long incisions the knife is held like a violin bow (Figs. 93, 94). For finer dissection the knife is employed after the manner of a pen (Fig. 95).

In dividing tissues from within outwards the knife is grasped in a similar way, but the cutting edge is now directed upwards (Figs. 96, 97, and 98). Incisions are made by a light, drawing movement of the whole hand, usually from left to right, seldom in the opposite direction.

The parts to be divided should be rendered tense by placing the thumb of the left hand on one side, and the index finger on the other side of the line of incision, and employing gentle traction (Fig. 99). To more effectually stretch the skin the operator may employ the fingers of the left hand on one side, whilst an assistant exercises traction on the other side of the line of incision (Fig. 100). When important vessels

lie immediately beneath the point of incision it is sometimes convenient to raise the skin in a fold (Fig. 101).

When considerable force is required in making an incision the

Fig. 92.

Fig. 93.

thumb may be firmly applied to the skin, and the knife guided by the other fingers (Fig. 102): this prevents deviation from the straight line.

Fig. 94.

Fig. 95.

In dividing very hard tissues, like horn and bone, the knife employed is grasped with the whole hand (Fig. 103).

Fig. 96.

Fig. 97.

Incisions should be made rapidly and, if possible, of the predetermined length at one stroke. Too short an incision impedes the deeper stages of the dissection, and is no advantage, for the linear cicatrix which may remain is of even less importance in animals than in man. Moreover, the irregularity of the incision produced by a series of cuts greatly militates against rapid healing.

Fig. 98.

Scissors are held as shown in Fig. 104, the thumb and ring finger in the rings, the index finger on the joint.

In dividing soft tissues the knife is either guided by a director

or by the finger (Figs. 105 and 106). In the former case the director, lightly held between the thumb and index finger, is introduced into an already existing opening in the tissues, a convex or pointed knife is

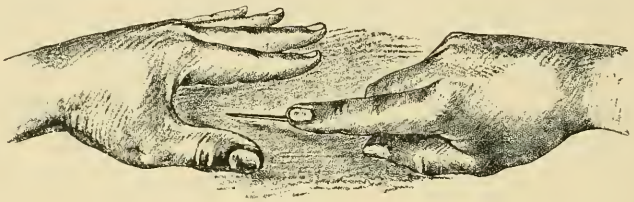


Fig 99.

slipped into the channel and steadily thrust orward with a lifting movement, so that at the end of the stroke it is nearly at right angles

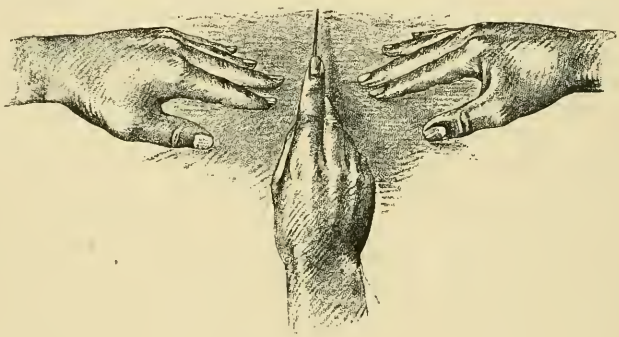


Fig. 100.

to the long axis of the director. In some cases it may be necessary to make the stroke towards the operator (Fig. 107).

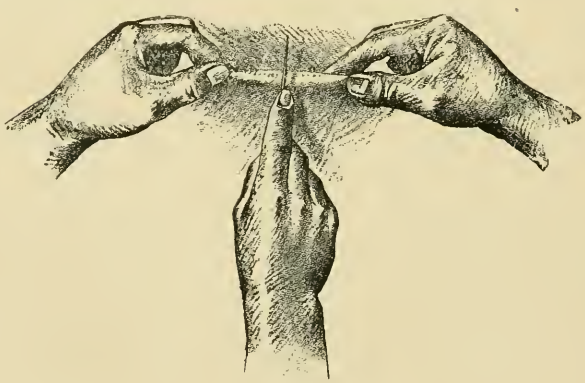


Fig. 101.

Where important organs might be endangered the operator grasps with forceps and raises a portion of the tissue to be divided, the

eighbouring portion being similarly raised by an assistant, and the parts divided between the two forceps. The forceps are then reapplied and the dissection so continued.

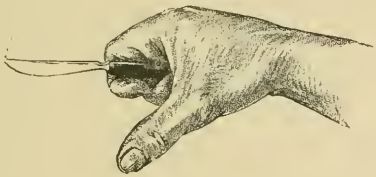


Fig. 102.

Fig. 103.

For holding the edges of wounds apart sharp hooks or retractors are employed (Figs. 78 to 80).

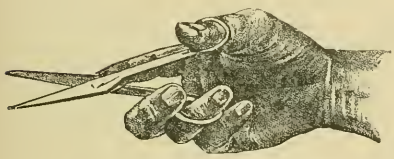


Fig. 104.

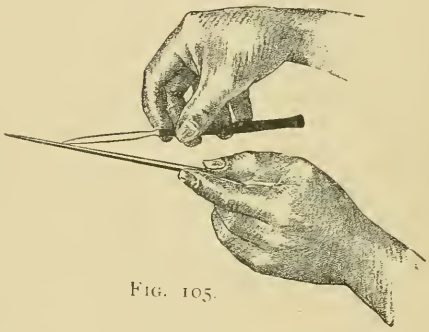


Fig. 105.

Loose tissues may either be torn apart by forceps, or divided with a blunt object like the handle of a scalpel or the rounded end of a

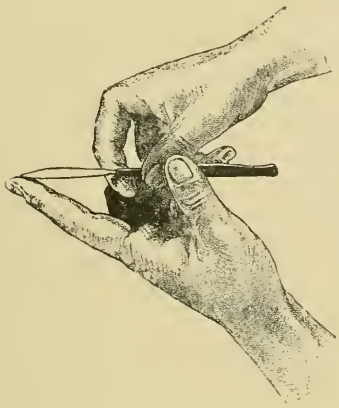


Fig. 106.

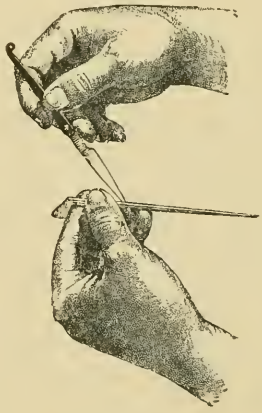


Fig. 107.

director. This method is used in exposing nerves and vessels. The forceps are held in the manner of a pen (Fig. 108).

When larger tracts of tissue are in question the fingers of both hands may be employed Although wounds so made are really torn wounds, and bleed relatively little, they often heal very rapidly.

Ligatures.—Soft tissues may be divided by passing around them a thin tightly-stretched cord. Linear necrosis continues at the point of ligation until the cord becomes slack, but inasmuch as many materials like reindeer sinew or metallic ligatures are comparatively inelastic, the ligature may after a time require to be reapplied, and large masses cannot be dealt with by a single ligature, but require several. In such cases the elastic ligature is exceeding useful. Being applied in a tensely stretched condition it "follows up" the parts as they yield. As stated, the ligature is applied in a stretched condition. After being firmly tied with a string or silk thread the ends are released, and as they immediately return to their previous volume they so greatly exceed the area of the knot as to render impossible

Fig. 108.

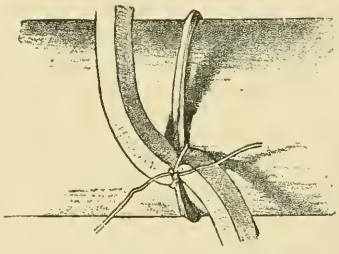


Fig. 109.—Diagram showing elastic ligature applied.

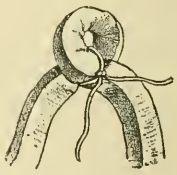


Fig. 110. — Diagram to show extent to which contraction proceeds.

any chance of retraction. Fig. 109 shows a ligature applied to a rod, and Fig. 110, the same ligature removed, to exhibit the degree to which it finally contracts. Solid rubber cords are better than drainage-tubes, which are apt to break when tied. An erroneous belief prevails that the thicker the part to be divided the thicker must be the rubber cord, but in reality a thin cord has a relatively greater power of contraction, and is therefore more useful. The surfaces left by the elastic ligature granulate readily. This method is especially useful in ligaturing very vascular tissues because vessels are securely closed before division occurs.

The Écraseur.—The écraseur effects the same result in a similar but more rapid fashion. It consists of an articulated steel chain, the loop of which is passed around the part to be divided and drawn tight until the tissue is finally crushed through. Chassaignac's écraseur (Figs. 111 and 112) acts by means of the two rods

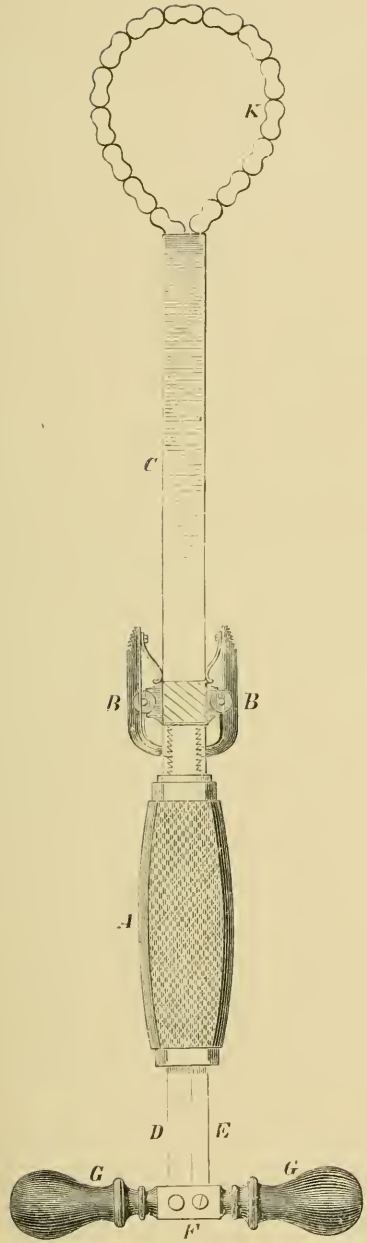


FIG. 111.—Chassaignac's écraseur.

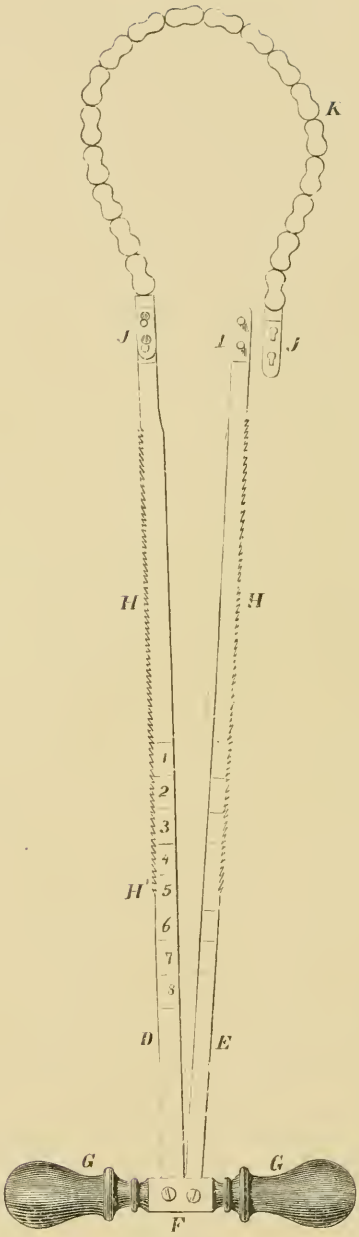


FIG. 112.—Chassaignac's écraseur dismounted, showing rack.

H H[1], *H H*[1], which are provided with teeth controlled by the two spring pawls *B B*. By slightly depressing the handle *G G* on either side, one of these rods is drawn forward a tooth and immediately secured by its corresponding pawl, when it becomes the fixed point through the medium of which the opposite rod is drawn downwards. The lower ends of the two rods thus act alternately as fixed points on which the handle *G G* swings. Reference to the figures will show that movement of this handle in the method described will cause the rods gradually to descend, drawing the loop of the écraseur *K* within the tube *C*, and slowly dividing any tissue enclosed within the loop *K*. In later écraseurs, such as Fig. 113, the movement is effected by a screw. At Professor Dewar's request Messrs. Arnold have produced an écraseur with a particularly neat and effective catch by means of which the screw can be thrown into and out of action very readily. When the catch is in the position marked "free" the "slack" of the chain

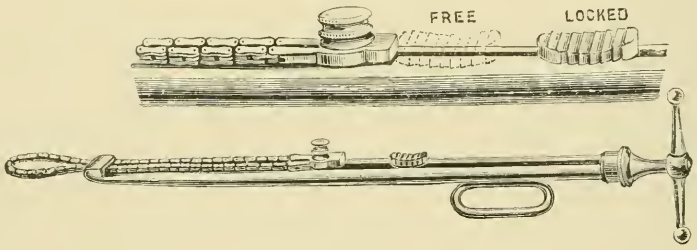


Fig. 113.—Professor Dewar's écraseur.

can be taken up so that the instrument is ready to commence cutting as soon as put in operation. By slipping back the catch the chain becomes locked to the screw, and the apparatus is ready for use. The screw movement is much preferable to the rack originally fitted in the Chassaignac instrument. The instrument is long enough for the castration of mares and cows in the standing position, and as the chain is bevelled on one edge it crushes through instead of cutting the tissues, thus avoiding a frequent cause of post-operative hæmorrhage. On the other hand it may be reversed if very fibrous tissues require to be divided.

Small and even medium-sized vessels may be divided in this way without bleeding. The action depends to some extent on the rapidity with which the process is carried out. The slower the movement the less the bleeding. For this reason very vascular tissues should be very slowly divided, and pauses should occasionally be made; between each movement of the handles, or each complete rotation of the screw,

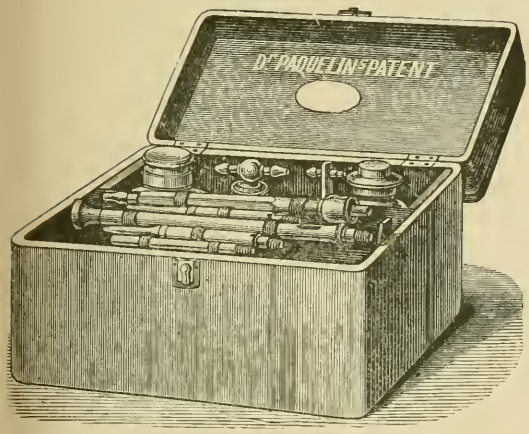


FIG. 114.—Paquelin's cautery in box.

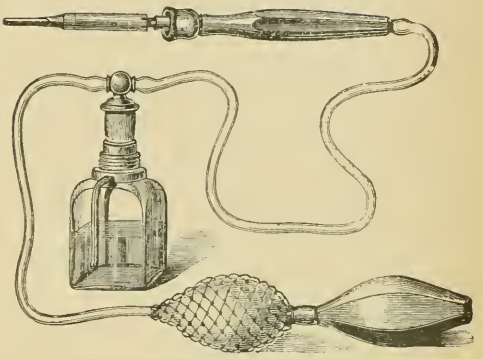


FIG. 115.—Paquelin's cautery in action.

FIG. 117. FIG. 118.

FIG. 116.

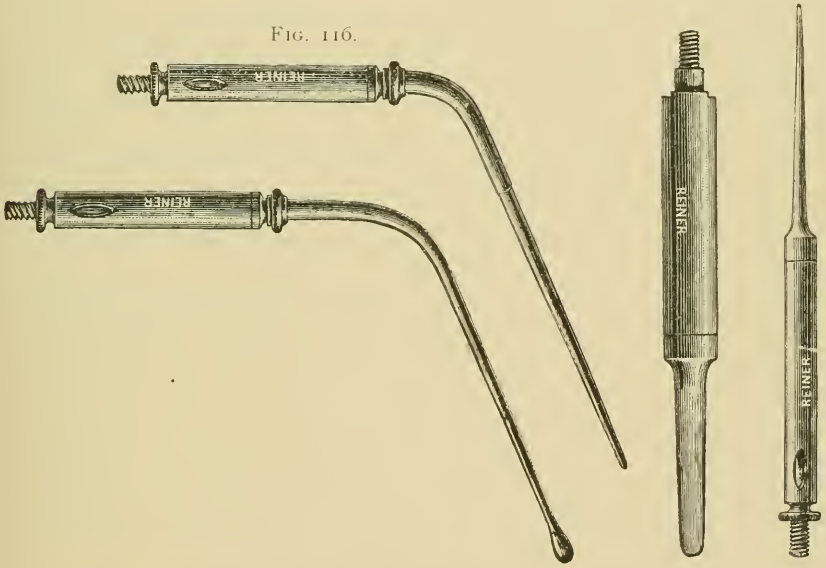


FIG. 119.

FIG. 120.

FIGS. 116—120.—Platinum heads for Paquelin's cautery.

fifteen to thirty seconds may be allowed to elapse. Specially thick tissues may be divided in two portions, the centre being perforated, and the chain applied alternately to either side.

The Galvanic or Thermo-cautery.—In the galvanic cautery a loop of platinum wire is passed around the tissue to be divided, and after being raised to a bright red heat by the passage of an electric current, is gradually drawn tight. On account of its complications and expense, however, this instrument is very seldom used in veterinary surgery, especially as Paquelin's thermo-cautery (Figs. 114, 115) renders almost equally good service and is much cheaper. The thermo-cautery consists of a hollow platinum terminal which may be of varying shape. After being heated in a spirit flame it is kept at a bright red heat by injecting a mixture of ether or benzine vapour and air into the head. Tissues divided by this instrument bleed very little, though the scab produced by the cautery must have a certain thickness, to attain which the division must be made deliberately. The wounds produced heal comparatively slowly.

Puncture.—A puncture is an incision of considerable depth but of comparatively small diameter. Puncture to permit fluids or gases

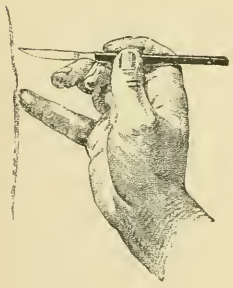


Fig. 121.

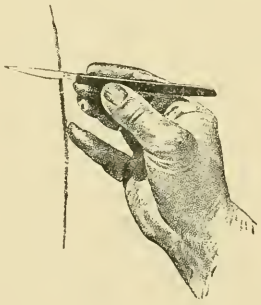


Fig. 122.

Fig. 123.

to escape from cavities, like the thorax, abdomen, or bowel, is termed paracentesis. To prevent the entrance of air into deeper seated tissues or into the cavity to be opened, the skin is often drawn to one side before operation, so that returning afterwards to its ordinary position it closes the deeper opening. Subcutaneous puncture may also be practised by first introducing the perforating instrument horizontally a short distance under the skin, and, after altering its direction, making the desired puncture; the walls of the opening immediately collapse on the removal of the instrument.

An ordinary pointed knife, bistoury, scalpel or lancet may be used for puncturing. Either of the former is held like a pen, the thumb

on one, the index and middle finger on the other side, the little finger being used as a support. The point is caused to enter vertically by extending the previously bent fingers. In withdrawing the instrument the opening may, if necessary, be enlarged, Figs. 121, 122.

In using a bistoury or lancet the handle is held at right angles to the blade. Many persons grasp the blade, only leaving uncovered sufficient to penetrate to the desired depth: but this method, how-

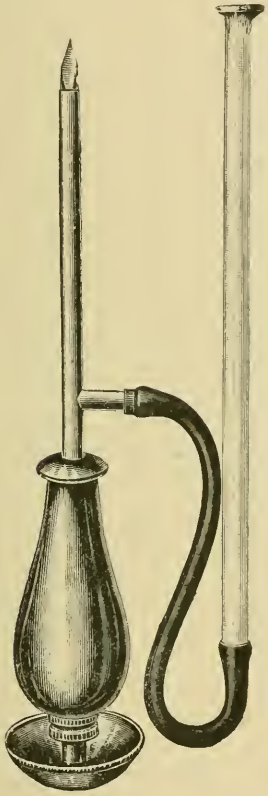


Fig. 124.—Trocar for tapping the chest.

Fig. 125.—Trocar for tapping bowel.

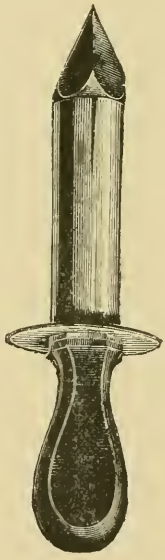


Fig. 126.—Trocar for puncture of rumen.

ever, has the disadvantage that in case of a mistake in regard to the thickness of the tissues to be divided the fingers must be moved, moreover the operator runs considerable risk of wounding himself. The surgeon should possess sufficient delicacy of touch to know when opposition ceases, that is when the cavity is entered. Supporting the instrument with the fingers in the method described assists in this respect.

The real puncturing instruments are suture and exploring needles and trocars.

Suture needles are held with the thumb on the concave, the index and middle fingers on the convex surface. Fig. 123. In using small, fine needles, a needle-holder is of great service, Figs. 155 to 157.

Pins are grasped with the middle finger and thumb, the index finger being placed on the head, or they may be inserted by means of a needle-holder.

The trocar consists of a pointed steel rod provided with a metal shield or tube, exactly corresponding with it in other respects but a trifle shorter. The rod may be of varying length and thickness, straight or curved, cylindrical or oval. The point is usually triangular in section. At the lower end of the cannula, where it abuts on the handle, are one or a pair of rings to permit of its being fixed into position by tapes. As a rule the upper end of the cannula discloses two short slits, which permit the parts to spring slightly and apply themselves closely to a trifling circular depression formed just below the point of the trocar. This device causes the instrument to enter much more easily, as the union of the trocar and the cannula then presents no projection. The handle of the trocar is grasped in the hollow of the hand, the fingers and thumb steady the stem, and in use the instrument is thrust into the cavity to be penetrated with a single rapid movement. The cannula is then fixed with the left hand and the stilette or trocar removed with the right. While withdrawing the cannula the skin in the neighbourhood of the puncture should be pressed down with the thumb and index finger of the left hand to prevent it being lifted.

Fig. 127.

Fig. 128.

Division of Hard Tissues.—The horn of the hoof is divided with a special knife grasped with the whole hand, Fig. 103. Bones are divided with drills, chisels, saws, and forceps. The bone is prepared for sawing by removing the periosteum with a chisel or gouge, Figs. 127–8. Files and rasps are sometimes used to remove sharp edges or projecting points from sawn surfaces. In this connection, the sharp spoon or curette, Figs. 129–31, used for scraping diseased bones and cartilages, unhealthy granulations, callous walls of sinuses, etc., deserves mention. It is not sufficiently known or valued in veterinary surgery. It con-

sists, as the name indicates, of a small steel spoon with a sharp edge attached to a stem and handle. The most useful are the smaller because they can readily be passed into sinuses, in certain cases into bones, and into all hollow spaces formed of diseased tissue. A selection of various sizes ought, however, to be kept. Curettes are sometimes formed with

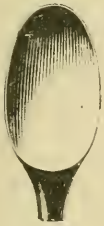


Fig. 129.—Curette.

Fig. 130.—Curette.

Fig. 131.—Curette with irrigating attachment.

hollow handles, and an arrangement by which a stream of disinfecting fluid can be caused to flow from the bottom of the bowl, Fig. 131; the material loosened is washed away by the stream of fluid. The curette

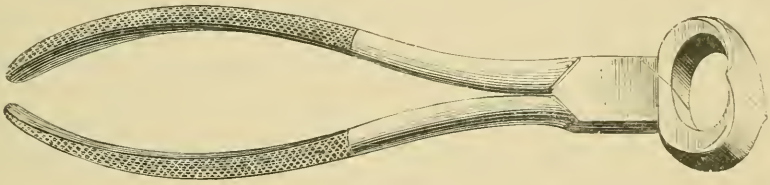


Fig. 132.—Bone forceps.

is held in the full hand and used with considerable pressure. The sharp edge of the spoon removes necrotic tissue whilst gliding over firmer healthy parts without affecting them. Particular care must be

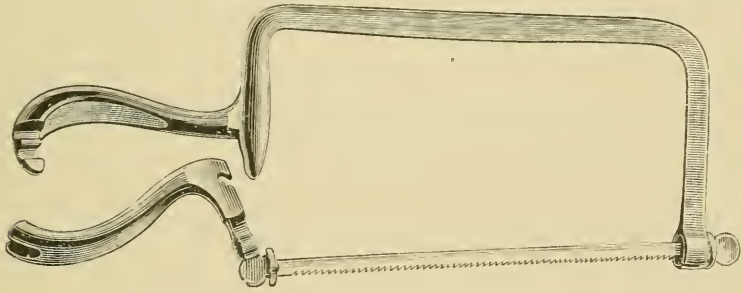


Fig. 133.—Frame saw for bone.

taken to remove everything of a diseased nature, without which rapid healing need not be expected.

The chisel and gouge, Figs. 127 and 128, are now seldom employed for dividing bones because of the danger of shattering the bone when

using the mallet or hammer. They have largely been replaced by bone forceps, Fig. 132, which are made with blades either at right angles to the long axis of the forceps or parallel with it. Each form has special uses.

Saws are of several forms. The frame saw (Fig. 133) consists of a blade, a frame, and a handle. The blade is made somewhat finer towards the back, so as to saw freely and not become fixed in the furrow. It is secured at one end by a screw for regulating the tension, and at the other carries a small rivet which prevents the blade slipping through the slot into which it is introduced. The frame is either quadrangular or semicircular. The handle was formerly provided with depressions to fit the fingers. As, however, this rendered it difficult to clean, modern saws are provided with plain curved handles.

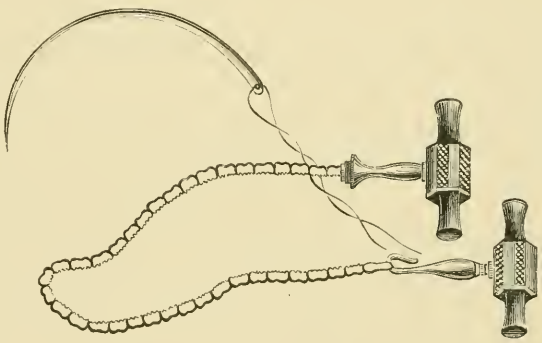


Fig. 134.—Chain saw.

The nature of chain saws is almost sufficiently indicated by their name. They consist of a number of articulated links, carrying on one side saw teeth (Fig. 134). On account of their cost, however, they are not much used in veterinary surgery. The end of the chain is passed around the bone by means of the needle and thread shown, and is then attached to the handle; by drawing the chain to and fro the bone is gradually sawn through. A trephine consists of a hollow steel cylinder bearing teeth on its free border. A central terminal steel point is usually added to steady the trephine in position, and by rotating the handle alternately towards the right and left a circular piece of bone is gradually cut through. Trephines are mostly used for opening the sinuses of the face.

CHAPTER VI.

SETONING.

In certain conditions it used to be, and to some extent still is, the custom to set up chronic inflammation and suppuration under the skin in order to influence processes going on in the neighbourhood. For this purpose setons consisting of a broad piece of tape or cord of plaited horsehair are passed beneath the skin by means of special instruments.

Although active inflammatory processes in the skin certainly appear to affect the condition of deep-seated tissues, this action is probably not so important as is believed, and when visible improvement occurs one is not without a suspicion that the indispensable rest has played an important part in producing the result. Blisters achieve somewhat similar results without leaving the mark which always occurs to a greater or less extent after setoning. The use of setons to effect healing of abscesses and hæmatomata was frequent in former times. Inasmuch as healing may be produced much more rapidly and satisfactorily by opening the hæmatoma at the deepest point and applying steady pressure, the use of setons for this purpose is not to be commended, nor is it any more advisable in the treatment of sinuses, because it does not prevent the continued formation of pus nor the extension of chronic inflammatory processes or necrosis in the deep parts, without which the sinus would heal of itself. Such canals may be much better and more rapidly dealt with by direct operation and the removal of all diseased tissue by the curette. For these reasons the employment of setons has greatly diminished, and, inasmuch as their use invariably entails prolonged rest, there is always some reason for casting doubt on its direct beneficial result. As, however, opinion is

still divided on the point, and as many practitioners appear to place faith in the operation, a diagram is furnished below showing the position in which setons are introduced for various conditions. Setons are inserted with a special needle (Fig. 136), from eight to sixteen inches in length, and usually made of steel or soft iron. The point is spatulate and of steel, the body is usually flattened and often divided into two parts, which can be screwed together. The eye is sometimes at one end, sometimes at the other. For the purpose of passing frog setons Sewell invented a special needle (Fig. 136A). For operating on hæmatomata, etc., the needle shown in Fig. 136B is used. It consists of two cylindrical

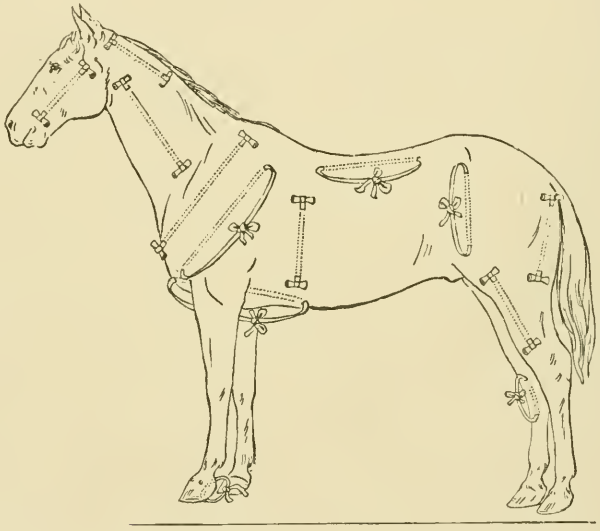


FIG. 135.—Schema showing positions in which setons may be inserted.

portions about three sixteenths of an inch in thickness, which can be screwed together. The point resembles a three-sided pyramid.

Should the animal prove very troublesome it may require to be cast before a seton can be inserted, but as a rule it is sufficient to apply a twitch and lift one of the fore-feet. Speaking broadly, it is best to pass the needle from below upwards, as should the animal struggle it is more easily withdrawn, while it is less likely to go astray. Should it be inserted in the opposite direction and an error be made necessitating change of direction, a pocket is left in which pus may accumulate.

Views differ as to the depth to which setons should be inserted. Some prefer the subcutaneous tissue, others penetrate beneath the

panniculus. The latter method, however, is sometimes followed by troublesome extension of the suppurative process, and is not to be recommended.

Having selected the lowest point, the skin is raised in a fold and either divided with special scissors or with a knife. The point of the needle is then introduced, with its flat side towards the

Fig. 136.—Seton needle with eye in head and also at base.

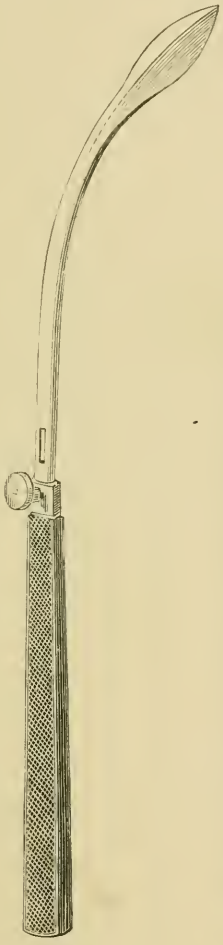


Fig. 136A.

Fig. 136B.

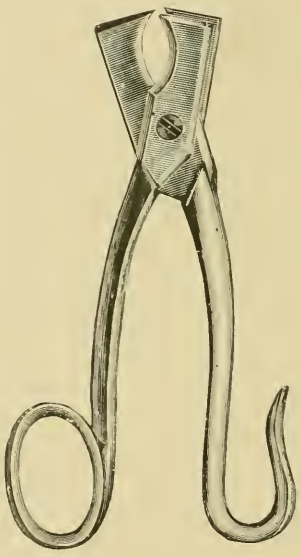


Fig. 137.—Rowelling scissors, for making the preparatory incision when inserting seton.

skin, and the needle thrust forward, its course being carefully noted, and if necessary controlled by the fingers of the left hand. The needle used in France possesses a sharp point, and therefore readily penetrates the skin at the end of its course: but with the common English needle it is necessary to make an incision for

exit. The point of the needle is then grasped with fingers or forceps, and withdrawn through the upper orifice, bringing with it the tape with which it has been threaded. If, however, the eye is in the point of the needle the tape is not inserted until the eye appears through the upper wound. The tape is then passed and the needle withdrawn, leaving the tape in position. The tape, which must be at least twice as long as the channel to be produced, is secured by firmly tying the ends together or by attaching each end to a transverse piece of rubber tube. The disadvantage of uniting the ends consists in the danger of the loop so formed catching on a hook or other object or being grasped in the horse's teeth, and the entire seton being torn out. To prevent this the horse should be tied up or a side-stick applied. In dogs a muzzle must be put on.

To increase the action the seton is smeared with irritants, and is daily moved up and down. As soon as suppuration occurs, free drainage should be secured by fomenting the orifices daily and gently stroking the channel from above downwards. The seton may be left in position from eight to twenty-one days. To remove it the upper end is snipped off with scissors and the tape drawn downwards.

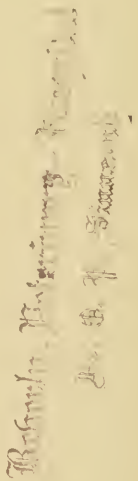
Inserting a frog seton demands certain special precautions. The horn around the point of the frog having been thoroughly thinned, an incision is made above the bulbs of the heel, and the special needle, with its convex side directed towards the tendons, is thrust downwards towards the point of the frog, the foot meanwhile being extended as far as possible. The needle should appear near the point of the frog. The ends of the tape are knotted together and a dressing applied.

Blood-vessels may be wounded in passing setons, but as only small twigs are usually affected no special precautions are called for. Where nerves are injured paralysis may result, and in some cases tendons, tendon sheaths, and joints have been opened. Passage of a seton under fasciæ or the panniculus sometimes produces extensive suppuration and burrowing of pus. Where a seton is left too long in position the walls of the channel become thickened; while should the animal not be carefully secured and watched the seton itself may be torn out.

An operation now almost entirely discarded is the insertion of "rowels," "issues," or "plugs." An issue was produced by incising the skin and thrusting a foreign body, like a fragment of leather or of white or black hellebore, into the subcutaneous tissue. In horses the spot most often chosen was the chest, close to the

ensiform cartilage, although other places, such as the forehead, cheeks, jugular furrow, side of the neck, front of the chest, shoulder, abdomen, and even the hoof were sometimes selected. In cattle the dewlap is usually preferred.

The horse was twitched, and a fore-foot lifted or the hind foot secured; an incision was then made at the spot chosen, the skin separated from the subcutaneous tissue to form a pocket, and the issue inserted. When the issue was inserted at a point where the surface of the body was nearly vertical, the skin was separated from below upwards in order to prevent pocketing and accumulation of pus. The fragment of leather was usually circular in shape, and covered with tow smeared with some irritant. It was doubled before being inserted, and afterwards flattened out to prevent its escaping from the incision.



CHAPTER VII.

INOCULATION.

By inoculation is meant the intentional conveyance of infectious material to a healthy subject. A wider meaning is sometimes attached to the term, causing it to extend to the products of micro-organisms such as antitetanic and antidiphtheritic serum, mallein, etc. The reasons for inoculation vary. At the present day inoculation is a most important process in studying the life history of bacteria, their nature, virulence, mode of action, etc. Animals, again, are inoculated to protect them against certain diseases, like pleuro-pneumonia contagiosa, black-quarter, anthrax, and swine plague (rouget du porc), to produce new (modified) infectious material (vaccine), and finally, though not very often, to shorten the duration of epizootic diseases. Various forms of needle are used for inoculation. The oldest is Sick's (Fig. 138). A longitudinal furrow in the middle of the head holds the infective material. From the centre of the lancet-shaped head the sharp cutting borders converge to form a fine point.

Fig. 139 represents Pessina's needle. In use the furrow is filled with infectious material, the needle thrust under the skin, revolved and withdrawn, leaving the infective material within the wound. Inoculation may also be performed by first slightly scarifying, really only irritating the skin, and then rubbing in the infective material. To produce a large number of incisions at one stroke a special compound spring scarifier has been made, though it is not indispensable.

Sticker employs a special needle (Fig. 140) for pleuro-pneumonia inoculations. It consists of a hollow needle provided with a small opening just below the slightly curved point. The handle has a movable pressure button, which injects a small quantity of fluid into

the wound through the before-mentioned aperture. The needle is thrust under the skin, and the infective material injected by pressing

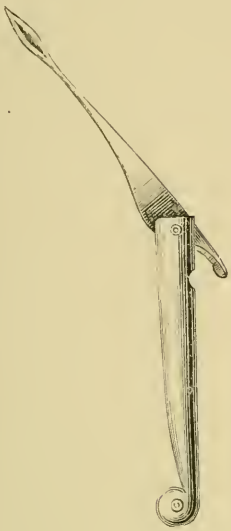


FIG. 138.

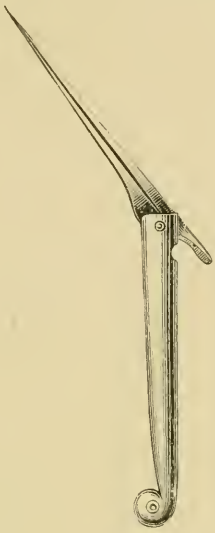


FIG. 139.

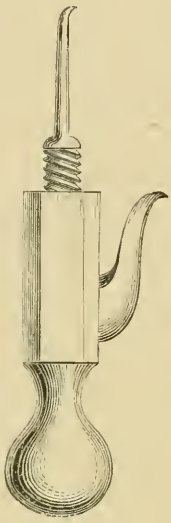


FIG. 140.

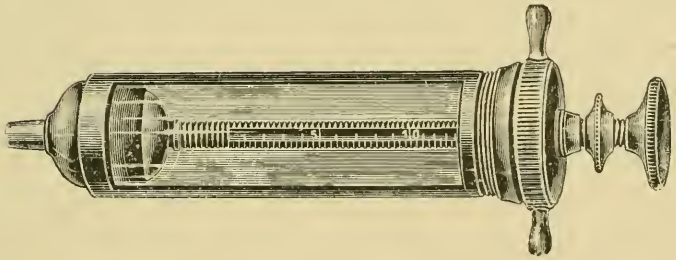


FIG. 141.—Sterilisable syringe; ready for use.

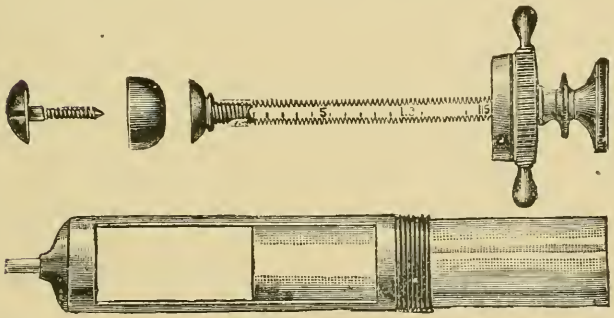


FIG. 142.—Sterilisable syringe; dismounted.

on the button. The instrument is really only a kind of syringe for subcutaneous injection.

Nowadays, however, syringes are almost universally employed for protective inoculation, as well as for the injection of mallein and tuberculin for diagnostic purposes, an operation which is closely akin to inoculation, and is carried out in a similar way. As a rule the stem of the syringe carries a movable stop which can be fixed at a pre-arranged point, allowing only the exact amount of material to be injected at each operation. Such syringes are now made with asbestos or metal plungers, and can be taken to pieces, or are of such a nature as not to be injured by boiling.

Before making the injection the point of operation should be shaved and thoroughly disinfected. Care must be taken that the fluid really penetrates beneath the skin and not into it or into the muscular tissue, as often happens. Neglect of these precautions, and failure to thoroughly sterilise the instruments, explains most of the cases of inflammation, abscess formation, and other complications after inoculation.

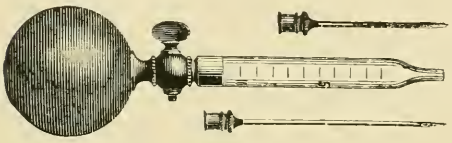


FIG. 143.—Roux's sterilisable syringe without piston.

It almost appears as if the action of the infective material varies according to whether it enters the skin or subcutaneous tissues, a fact which probably explains the totally different results produced by two different operators with one and the same material. The best plan is to raise a fold of skin with the left thumb and forefinger and rapidly thrust the needle through the skin in the length of the fold. The fluid is spread over a larger surface by gently manipulating the parts after removing the needle.

After each injection the syringe and needle must be thoroughly washed and boiled, or at least disinfected.

As a rule no special restraint is needed, as the pain is very trifling. In large vaccine institutes the animals are usually secured on movable operating tables.

CHAPTER VIII.

CAUTERISATION.

The destruction of tissue by chemical substances or by burning is termed cauterisation. Such chemicals are comprised under the general heading of caustics, whilst the red-hot iron or other heated instrument is termed the actual cautery. Cauterisation produces a scab or scar. The dead tissue is separated by reactive inflammation, and is cast off; healing follows by granulation. Apart from destroying diseased tissues and stimulating repair in strained or chronically inflamed tissues, cauterisation is often invoked merely to produce very active irritation, sometimes to hasten granulation and cicatrisation, or to close bleeding vessels by means of a scab, and thus to check hæmorrhage.

Chemical Caustics

May be divided into fluid and solid. Fluid caustics can be applied in small quantities with a brush, glass rod, or pledget of cotton wool, etc., to the point to be cauterised, care being taken never to apply so much as to render possible the spread of the caustic beyond its intended position. If considered necessary to exactly delimit the extent of tissue to be cauterised the skin may be shaved, and a plaster containing an aperture of the desired size applied, or a mass of soft plaster may be formed into a roll and affixed to the skin around the point to be operated on, forming a little basin to receive the caustic and protect adjacent parts.

Of fluid caustics may be mentioned:

Sulphuric acid, which acts very rapidly and powerfully on account

of the energetic way in which it removes water from living tissues and coagulates albumen. It produces a hard black scab, which remains in position a very long time.

Fuming nitric acid produces a yellow scab, which is at first softer than that produced by sulphuric acid, but later becomes dry and hard. The yellow colour is due to the formation of xanthoproteic acid, a combination of nitric acid with albumen.

Hydrochloric, carbolic, and chromic acids act less powerfully than nitric or sulphuric acid.

Among solid agents, caustic potash exercises a very marked and penetrating action. It can be applied solid or in solution. Sticks of fused caustic are to be preferred. The point is pressed on the part to be cauterised until the intended amount of action has been produced. Caustic potash, like some caustics previously mentioned, acts by abstracting moisture from the tissues. It forms a greyish-yellow scab sometimes mixed with blood. As this scab readily

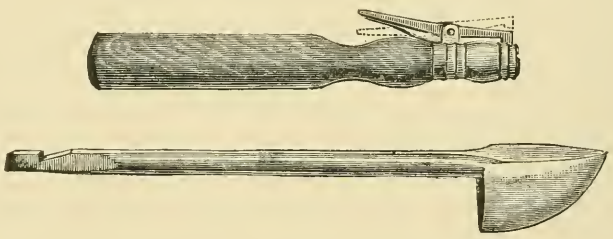


FIG. 144.—Line firing iron and handle (interchangeable).

breaks down and becomes fluid, the surrounding parts must be carefully protected from its effects. A special caustic is used in Vienna, consisting of six parts of caustic lime and five of caustic potash moistened with alcohol to form a paste, which can then be applied to the skin to the extent required. This paste does not run or spread.

Sublimate (bichloride of mercury) is also a powerful caustic. It destroys tissues by combining with their albumen, and forms a soft grey scab, which afterwards darkens and slowly separates. Sublimate is employed as a powder, paste, or solution. Sublimate collodion consists of five parts sublimate dissolved in thirty parts of collodion.

Arsenious acid, or white arsenic, is usually employed in the form of paste. The action is slow, the scab firm and durable.

Chloride of antimony, otherwise known as butter of antimony, has a powerful action, and produces a whitish, at first soft and afterwards hard, sharply defined scab.

Chloride of zinc is an energetic caustic, and may advantageously be used by mixing one part zinc chloride with one to four parts of flour, water being added to form a paste.

Nitrate of silver and the sulphates of copper and zinc are perhaps the caustics most generally employed. Nitrate of silver, or lunar caustic, has only a superficial action. The scab is at first white and soft, later becoming dark under the action of light. Sulphate of copper is cheaper than lunar caustic, and is sometimes used to destroy exuberant granulations. The same is true of sulphate of zinc, which is perhaps less frequently employed.

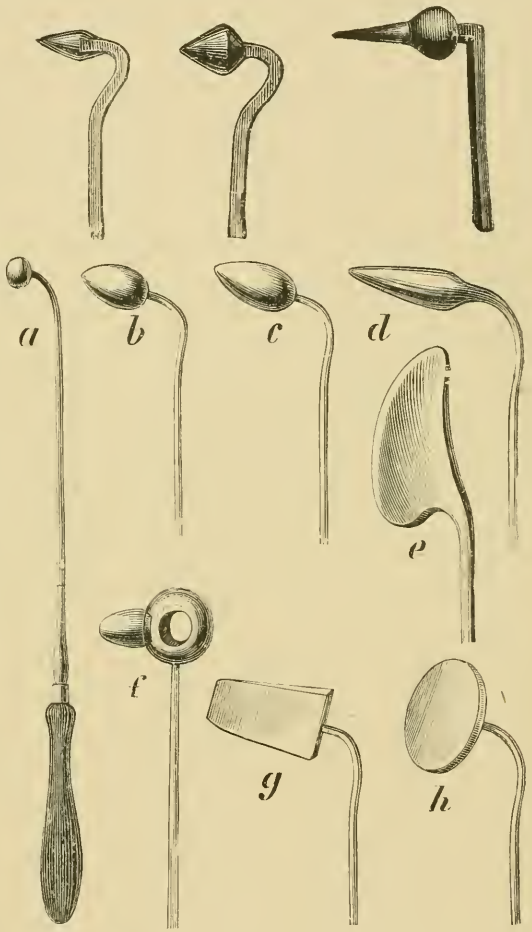


Fig. 145.—Bud, point, line, and disc firing irons.

The longer the caustic remains in contact with the tissues the more extended is its action, as it continues to spread from the fresh scab. Where the action proves insufficient it may be renewed as soon as the scab is shed. For destroying new growths, caustics in the form of pastilles or rods are sometimes used, an incision being made in the growth for their introduction. In other cases solutions are injected. These methods, however, are not to be commended because the range of action of the caustic cannot be controlled. Sometimes a portion of the growth is left, necessitating a second operation; sometimes the action of the caustic extends to healthy tissue with unfortunate results. The caustics, and especially the more active, produce severe and continued pain during their action.

The Actual Cautery—Firing.

Although much less used than in the early part of the century firing still continues very popular, and is employed with success in many conditions which have resisted all other treatment. Without doubt it gives lively pain, necessitates a certain period of rest, and

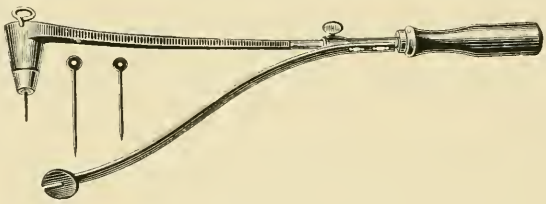


Fig. 146.—Needle firing iron with interchangeable needles.

sometimes leaves indelible marks, but these drawbacks are more than counterbalanced by its many advantages. Among the indications for the employment of the actual cautery, the most frequent are chronic affections of tendon sheaths, of bones and articulations, synovitis,

Fig. 147.—Dégive's needle firing apparatus packed in box.

hydrarthrosis, sprains, luxations, exostosis, periostosis, enlarged joints, caries, or necrosis. It is also employed in disease of tendons, chronic inflammatory changes in connective tissue, and as a remedy for certain cysts. Furthermore it is used to divide tissues, to remove chronic lymphatic thickening, to stimulate the healing of fistulæ,

indolent ulcers, and poisoned wounds, in the treatment of tumours and septic engorgements, and to check hæmorrhage. Distinctions have been made between mediate and immediate, superficial and deep or penetrating firing. In mediate cauterisation, a glowing iron is brought close to the spot to be acted on so that the parts are merely heated by radiation; in immediate cauterisation, the instrument is brought in actual contact with the tissues. Surface firing, *i. e.* firing extended areas all over, and the application of burning pastilles (moxas) are now entirely abandoned.

The only methods at present used are (1) superficial firing in the form of points or lines, the instrument not passing deeper than the epidermis itself; (2) deep firing in fine points, where the skin is penetrated at

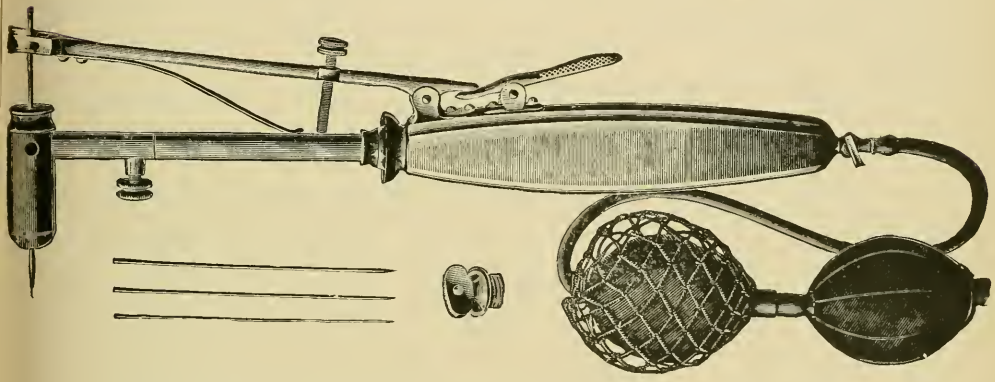


FIG. 148.—Dégive's apparatus ready for action. The reservoir in the handle is filled with sponge saturated with benzine vapour. The bellows pump air through this reservoir. The stream of benzine-laden air is mixed with a stream of pure air controlled by the two-way tap at the base of the handle, and burns with an intensely hot blue flame in the hood. The tap at the base of the handle regulates the size of the flame, and therefore the temperature.

one or a number of spots; (3) needle firing, in which the instrument penetrates as deep as the muscles, tendons, ligaments, bones, or synovial sacs; (4) subcutaneous firing, practised after the skin has been divided with a knife.

The instruments used for line firing are provided with heads resembling wedges or triangular prisms. The cauterising margin should be slightly convex, smooth throughout and rounded at the angles; a slight curve in the stem is thought by some to be advantageous. With instruments of this form it is easy to follow the inequalities of the parts and to ensure each part being subjected to the same action. Fig. 144 shows the ordinary form of the English firing iron. It is suitable for most purposes. The length of stem varies according to whether it is intended for use on the animal in a standing position or

when cast. Messrs. Arnold make these instruments in many forms, all fitting one handle. The head of the point or bud-firing iron consists of a more or less elongated cone: for deep firing it is drawn to a much finer point. Needle firing is performed with very fine points, capable of penetrating the tissues deeply. It was formerly the custom to use stout needles, about four inches in length, which were brought to a red heat in a charcoal furnace, grasped with pincers or forceps and plunged into the tissues. These were replaced by instruments consisting of a heavy cone-shaped head, with a central aperture through which a suitable needle could be passed. The head was first heated, and when red, the needle was dropped into position. In the greater number of such instruments, however, the needles become cold very rapidly, and the large head cauterises the skin around the perforation. To protect the skin it becomes necessary to place a small disc of iron with a central aperture over the point of operation. Several instruments with movable needles have been invented. Dégive's (Figs. 147 and 148) is probably the best, though similar instruments have been produced by Bourguet and De Place. It consists of a handle, which also acts as a benzine reservoir and saturator, carrying at its extremity a small iron box with a conical base, through which is drilled a hole for the passage of the needle. This latter is held on a movable arm, which permits it either to be extruded through the base of the box or to be retracted within the latter by a spring. A bellows and benzole container supply the heat, the flame playing within the cavity of the iron box. Each time a puncture is to be made the red-hot needle is extruded from the point of the box and thrust into the tissues. The action of the spring automatically returns it to the interior of the box, where the flame almost immediately renders it hot again.

The two following firing instruments were described by the writer some years ago (see 'Veterinarian,' February, 1898, p. 70). The first has been used by him in his practice for nearly ten years, the second for nearly four, and both have been found very satisfactory. The first is Graillot's Zoo-cautery (Fig. 149).

It is an adaptation of Paquelin's, which depends for its action on the peculiar property possessed by metallic platinum, and in an even higher degree by platinum in a finely divided state (platinum-black), of bringing about chemical combination between oxygen and hydrogen gases, or between oxygen and certain hydrocarbon vapours, without the intervention of a flame. The zoo-cautery consists, as shown by the annexed rough sketch, of three principal parts, viz. the handle, forming a benzoline reservoir, the stem, and the head.

The handle (B) is formed of thin metal, spun on a lathe and

corrugated, both to afford a better grip and to increase the surface from which evaporation takes place. Its interior is packed with fragments of sponge saturated with benzoline, and through the centre passes a small tube, which conveys a portion of the air pumped into the apparatus directly towards the stem, without passing through the sponge. At the extreme end of the handle is a nipple, over which is slipped the india-rubber tube of the bellows, and a little two-way stopcock (A), which when turned in a line with the handle allows air to pass freely both through the small (direct) tube mentioned, and also through the mass of sponge in the handle; but when turned at an angle gradually shuts off the stream from the sponge-packed part until at last (at right angles) it admits air alone through the direct tube. By examining the top of the handle before screwing in the stem the small *direct* air-tube will be seen projecting upwards through the mass of sponge.

The stem (C) is merely a strong metallic tube supporting the head, and conveying to it the mixed air and benzoline vapour delivered from the handle. At its upper part is a clamping nut, by means of which the head can be set in a line with, or at any angle to, the stem.

The head consists of a hollow nickel shell carrying at its extremity the cauterising surface or point, made of platinum-iridium alloy, and lined within by fragments of fine platinum gauze to assist the combustion of the vapours. Special attention is directed to the screw (D) shown on each of the heads, as it plays an important part in the working of the apparatus.

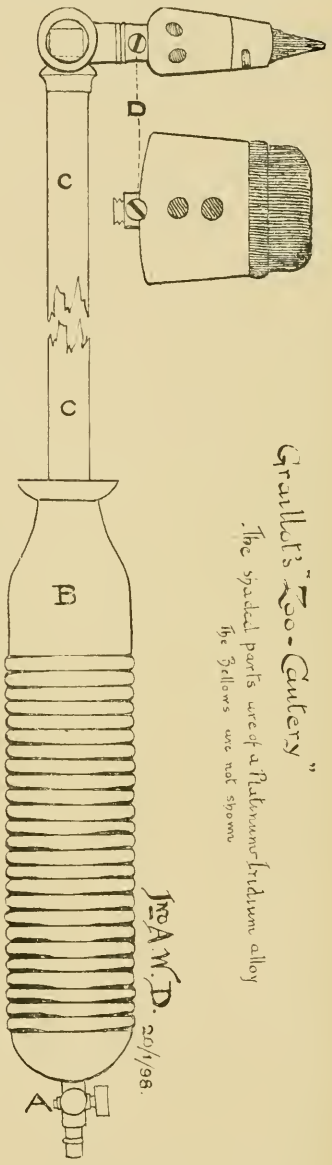


FIG. 149.—The zoo-cautery.

To start the cautery in action, the stem is first unscrewed, and benzoline poured into the handle from the upper end until it overflows. The handle is then inverted, and all excess of benzoline

allowed to flow away, leaving the sponge saturated. The parts are then screwed together, the bellows affixed and started, the little two-way stopcock (A) at the bottom turned nearly at right angles, the small screw (D) *in the head* opened as far as possible, and a light applied to the holes shown in the head. If all is acting properly, a strong bluish flame will be seen within the head, and a rather loud hissing sound will be heard. If not, the bottom stopcock is turned one way or the other, so as to alter the proportions of air and benzoline vapour passing to the head, until the flame appears and burns steadily. In a minute or two the entire head will become strongly heated, and if the top screw (in the head) be then turned home, the blue flame will disappear, the hissing noise will cease, and the point of the cautery, previously quite dull, will suddenly begin to glow, and soon attain a bright reddish-white heat. The reason of this is that the direct flame is extinguished, and the vapours are caused to burn *within the platinum point* or head. The instrument is now ready for use, and will continue acting for twenty minutes to half an hour by simply working the bellows. Should the heat decline, a slight turn of the lower stopcock will admit more benzoline vapour, and restore the required temperature. If employed in the open air some precaution is required when starting to shield it from draughts. A point of considerable importance is to obtain the right kind of benzoline; the common benzoline sold in oil-shops for use in cabmen's lamps or in the little cheap night lamps seems to answer best.

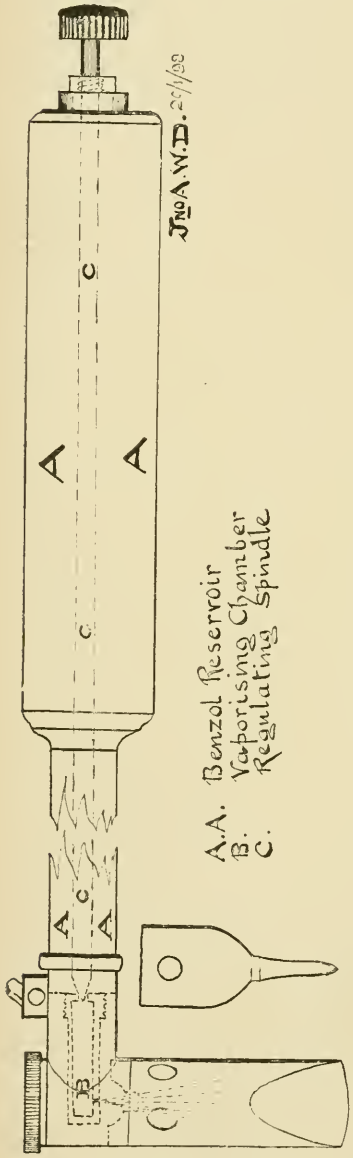


Fig. 150. Déchery's automatic cautery. The dotted lines indicate the position of essential portions of the interior.

The second instrument shown (Fig. 150) is quite different in principle

from that of Paquelin, and has the great advantage of being automatic in action when once started, and of requiring no bellows. Every one has probably seen the flaring, roaring lamps used in carrying on railway works, large building operations, etc., at night; the roaring noise and the intense light distinguish them from others. Déchery's cautery is a modified reproduction of one of these. It may be divided into reservoir (A A), vapour-chamber (B), and burner. The illustration shows these, the essential portions of the interior being indicated by dotted lines.

To resist the considerable pressure at which it works, the instrument is strongly made of nickelled brass. The reservoir is shut off from the vaporising chamber by a conical valve, worked by means of a long spindle (C) carrying at its extreme end a milled nut. The vaporising chamber consists of a small brass casting, hollow in the centre, and presenting two apertures—that at the bottom, through which the benzol enters, being closed by the conical end of the spindle; and a second, extremely small one at the side, through which the vapour issues at high pressure. As will be noted (see Fig. 150), this minute stream of high-pressure benzol vapour then rushes through a rather wide tube, inducing in its passage a smart current of air, with which it becomes intimately mixed, and finally burns in the head with a bright blue, smokeless, but intensely hot flame.

To start the apparatus the large bottom nut is unscrewed, and the reservoir filled with *carefully filtered* benzol. (It is important to filter the benzol carefully, as the smallest speck of foreign matter may choke the minute orifice in the vaporising chamber from which the vapour issues.) The parts are then screwed together, the valve spindle turned home, and the head heated in a spirit-lamp flame for two or three minutes. This warms the head and vaporising chamber, and prepares the apparatus for starting. As, however, there is at first no positive pressure within the apparatus, the benzoline would not flow into the vaporising chamber, and it therefore becomes necessary to heat the *stem*, so as to cause the benzoline to expand and to flow out when the valve is opened. The flame is therefore advanced a little, and allowed to play round the top of the stem for a minute or two, when, on opening the valve by turning the milled head with the fingers, a few drops of benzoline are injected into the heated vaporising chamber, are converted into gas, rush out into the head, become mixed with air, and burn into the outer part of the head, as above described. If the apparatus has been sufficiently warmed at the outset it now becomes self-acting, the heat of combustion being conducted to the vapour-chamber and the stem to a sufficient degree to promptly convert the

benzol into gas as it issues from the reservoir, and to keep the benzol in the reservoir itself nearly at boiling-point. It may be imagined, however, that the pressure in the apparatus would become dangerous and involve an explosion. Two safeguards are provided against this. Firstly, the apparatus is very strong: and secondly, an undue pressure in it would force benzoline outwards in such quantity as to produce large white flames, and thus give timely notice of danger. In practice the author has found the apparatus remarkably steady and reliable. The firing points and edges are easily heated to a bright cherry red, and the apparatus works without any regulating for twenty minutes to half an hour, when a turn of the milled head will enable one to continue for another quarter of an hour, a sufficient period to finish any ordinary operation.

As the whole apparatus would otherwise become unpleasantly warm, the main body of the reservoir is covered with a tube of insulating material,—"vulcanised fibre." The fact that the expensive platinum heads and points are entirely dispensed with permits of the apparatus being sold at a very reasonable sum.

For heating the ordinary iron a forge or small stove is usually employed. Charcoal or coke is preferable to coal. Within recent years, however, advantage has been taken of the numerous automatic lamps, burning petroleum spirit or benzole, to produce a convenient and easily transported stove. In these lamps the pressure produced within the body of the lamp by warming the fluid, causes a small quantity to mount through a capillary tube into a chamber surrounding the flame, which chamber is therefore always at a high temperature. Arrived here the liquid is rapidly transformed into gas, and escaping through a small hole, emerges in the form of a powerful jet which sucks air through orifices surrounding it, and when ignited burns with a very intense flame. By adapting to such a lamp a suitable hood for receiving the heads of the firing irons an excellent portable furnace is produced.

A very good form of automatic petroleum furnace is that shown in Fig. 151. The reservoir (*a*) contains ordinary paraffin oil, with which it is filled through the plug (*b*). To set the apparatus in action, the small air-pump (*c*) is worked for a minute or two, until the air pressure in the reservoir is sufficient to force the oil up to the burner (*f*). A little methylated spirit is then poured into the ring at the base of the burner and ignited, thus heating the burner. On then cautiously relaxing the screw (*C*), a fine stream of petroleum flows into the burner, becomes vaporised, and issues as a powerful jet from a small orifice at the base of

the tube (*f*), shown as a dotted line. This jet aspirates strong currents of air through the holes in the burner, mixes with this air, and burns with an intensely hot blue flame within the hood (*g*).

Whatever the method of firing adopted, certain general principles must be observed. The preparation of the animal is important. If casting is necessary it should preferably be done on an empty stomach; if the animal is very vigorous and plethoric, the food allowance should be reduced during the previous days, and laxatives may be administered. The point of operation must be thoroughly cleansed, and the hair cut either with a machine or with scissors, but in deep firing, implicating synovial membranes, antiseptic precautions are necessary. The cleaner the skin the less the danger of after-infection. For this reason, when firing in deep points, the writer usually applies over the whole area of operation a dressing wetted with 5 per cent. carbolic solution, which is allowed to remain in position for twenty-four hours, and to become dry by evaporation. It is removed immediately before operation, and is afterwards replaced by a dry dressing of boric acid and surgical cotton wool supported by a bandage. Where the points are less deeply introduced it suffices to smear the parts freely with boroglyceride after operation, omitting the cotton wool, etc. No blister is used. In applying the iron to certain regions where the skin is very mobile, it is well, if casting is necessary, to mark the outlines of the surfaces to be fired beforehand. Quiet horses are usually fired in a standing position, a twitch being applied to the nose, and the foot lifted to prevent accidents. In more extensive operations the parts may be rendered anæsthetic by subcutaneous injection of cocaine, or by the application of an elastic bandage or cord.

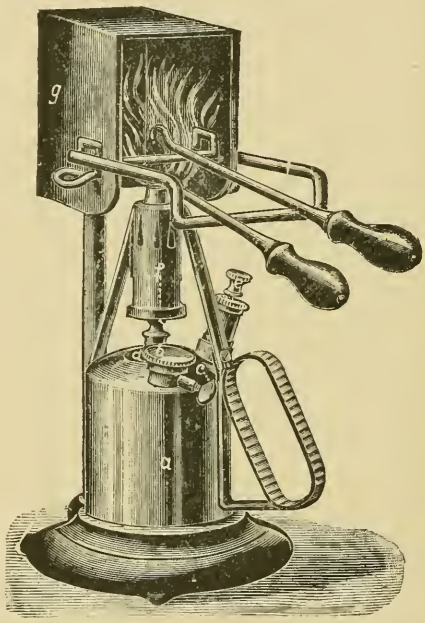


FIG. 151.—Automatic petroleum furnace and protecting hood for heating firing irons.

The most convenient apparatus for controlling animals when being fired is undoubtedly the operating table previously described. Firing, however, causing considerable pain, it is often necessary

where no such operating table is at hand to cast the animal. In operating on the external surface of a limb, the horse is cast on the opposite side. If the application is made around a joint, the animal should be cast on the diseased side and the inner face of the limb first operated on. In firing two limbs, the external surface of the one limb and the internal of the other are first completed, and when turning the animal over provision must be made against the cauterised surfaces being soiled.

Various manœuvres are sometimes necessary. As a rule the limb to be fired is left in the hobbles, while the opposite limb is released and either carried backward or forward. When the pastern or coronet is to be fired, the two limbs can be fastened together above the knee or hock respectively, the diseased limb being released from the hobble and drawn forward or backward by an assistant using a broad strip of webbing.

The important point is to trace equally spaced straight lines, and to extend beyond the diseased region. Converging lines should never cross or unite, the points of crossing being very liable to slough (see Fig. 152). The spaces between the lines vary according to the thickness of the skin and the extent of the cauterised region. Closely placed superficial lines are preferable to others more distant and more deeply penetrating. As a rule a space from three eighths to three fourths of an inch should divide the lines. In France the custom is first to lightly mark out the dēsign, and afterwards to pass over the lines a number of times. The iron is used at a dull or bright red, the latter being the maximum temperature allowed, and is passed slowly along the marked-out design without pressure, the blade of the cautery being always kept perpendicular to the surface. The iron should never be passed twice in immediate succession along the same line, and if the French method be adopted, the lines must be retraced in regular order, otherwise sloughing is apt to occur. When the cauterised surface is very small, it is well to wait for a short time between the first and second series of applications.

Fig. 152.—Pattern for line firing. The lines do not meet.

The operator judges when the cauterising action is sufficient by the appearance of the base of the lines, the exudation which has occurred, the infiltration of the skin, and the degree of separation shown by the epidermis. Judged by these standards, three degrees of cauterisation may be distinguished. In the first the lines are shallow and contain a few little drops of serosity. Their base is of a golden yellow, the skin is little infiltrated, and the epidermis

is still adherent. In the second the lines are deeper, their base yellowish brown, exudation is more marked, and the epidermis is loosened. In the third the epidermis is almost cut through, the margins of the lines tend to gape and produce irregular cicatrices, the serous discharge from their base is abundant, and the skin is often covered with blisters. In the French system the iron is heated to a cherry red, and is passed along each line five or six times in light firing, eight to ten in ordinary firing, and twelve to fifteen in severe firing. It is clear, however, that the number of passages must vary with the weight and temperature of the cautery, the judgment of the operator, and the thickness of the skin.

Superficial puncture or bud firing can often be performed in the standing position. The points must form a regular figure, those of one line corresponding to those of others adjacent. As a rule the points are separated by intervals of three eighths to half an inch, though they may be massed a little more closely where the most intense action is required. Here again the French prefer to apply the iron a number of times to the spots *seriatim*. The completion of the process is judged of by the same indications as in line firing. In England, however, it is unusual to apply the iron more than once, or at the most twice, a method which appears to be perfectly successful, and when combined with the after-application of a blister, to have the advantage of leaving less mark than the French method.

In deep point firing the cautery passes completely through the skin and into the subcutaneous connective tissue. The points must be disposed regularly, and at equal distances, though they may be placed rather more closely together than when firing the skin alone. With gentle pressure the cautery rapidly perforates the skin. This method has the advantage of being easy and rapid to carry out, and of producing a more intense and deeper action than that previously considered. The iron should never be applied more than twice. A light blister may be applied a few days after operation.

Until comparatively recent times the danger of penetrating synovial sheaths, etc., was regarded as excessive, and although a few practitioners like Basch, Fischer, and Robertson recommended puncture with fine pointed irons, the method was never extensively accepted, and when practised not infrequently led to disaster. In 1867 Bianci recommended puncture of dropsical synovial sheaths with the red-hot needle, a system which, after long discussion and some modification, is now becoming more and more popular. Care-

fully practised it is not dangerous, even for articular cavities, and considering the intensity of its action and its therapeutic value it constitutes a great advance on old methods. The point, however, must be extremely fine, those usually employed not exceeding one twenty-fourth to one sixteenth of an inch in thickness. When of iron these are difficult to make and to keep in order; platinum points like those supplied with the zoo-cautery are preferable. The punctures are best made in a regular design at intervals of about three eighths of an inch. The method of procedure is important: the needle, at a red heat, is sharply thrust to the required depth, and immediately withdrawn. There is no disadvantage in passing the needle more than once into fibrous or osseous tissues,—indeed, this is necessary to produce intense effects; but in dealing with synovial membranes the passage of even a fine needle more than once is dangerous. On the other hand, no bad results need be feared either from penetrating a joint or a synovial sheath, provided the puncture be made with a single application. The minute channels are aseptic when made with a red-hot instrument, and provided the needle be sufficiently fine, and the operation completed with one movement, they remain so. It is not necessary, however, in dealing with dropsical synovial sheaths that all the points should penetrate the sac; as a rule one actual puncture is sufficient. In other tissues two or three punctures may be made. In certain cases the operation may be terminated by the application of a blister.

The emollient dressings formerly employed after firing appear in the light of later experience to be contra-indicated, as they favour suppuration, retard healing, and tend to increase the area of the wounds and of the subsequent cicatrices. They should certainly not be employed immediately after operation. When the inflammation of the skin after firing is intense, antiseptic lotions or powders may be employed. If, on the other hand, the reaction is insufficient, a blister of biniodide of mercury or cantharides may be applied on the second or third day after firing.

The results of firing vary greatly according to the method employed. A day after superficial firing considerable swelling and more or less abundant exudation, especially from the lines or points, will be observed. The liquid dries, forming yellowish-grey crusts, covering the whole region. The horse has pain in moving, shows marked lameness and intense local itching. As long as this continues it must be closely watched, and care taken to prevent the parts being

bitten, scratched, or rubbed against neighbouring objects. The best method is either to tie the animal up short to a ring above the manger, apply a cradle or sidestick, or a dressing to the parts themselves. It is sometimes necessary to use a pair of hobbles connected by a short stout stick to limit movement of the legs as much as possible. The crusts become loose towards the eighth, tenth, or fifteenth day; to assist separation the parts may be bathed with warm water, or preferably dressed with an antiseptic ointment.

If the skin tends to crack, the parts are covered with boric vaseline or glycerine. At a later stage the scabs produced by the cautery disappear; when extending deeply and implicating the whole thickness of the skin they are sometimes very adherent, and only separate after a suppurative inflammation, leaving exuberant granulations, which are followed by indelible scars, the covering of hair never being restored.

While these processes are going on at the surface the subcutaneous tissues have become hyperæmic and inflamed, infiltrated with an abundant exudate, and the seat of active cellular proliferation. This condition is later followed by resorption, consolidation, and compression, results to which firing owes its beneficial action.

The effects of deep point firing are still more marked. The limb often becomes greatly enlarged, although a free serous discharge occurs through the skin. The small, closely-packed cicatrices in the skin and cellular tissue resulting from such firing form a kind of permanent compress which is much superior to bandages. It is certain that the retraction of these islands of new tissue exerts on the diseased part active compression resembling that produced by an elastic bandage The treatment of the patient differs in no essential respect from that required after superficial firing. The symptoms shown after deep needle firing depend on the depth of penetration and the nature of the tissues involved. Active inflammation always results in the region cauterised. The limb becomes greatly swollen, sometimes very hot and painful, while the animal shows more or less marked fever. Moreover, when a dropsical synovial sac has been opened synovia is frequently discharged, sometimes in large quantities, forming a yellowish-grey albuminous layer, which may even flow downwards over the foot or reach the ground.

At the end of two or three days this synovial discharge hardens, the apertures become obliterated, and the discharge ceases. The crusts separate during the second week; the scars begin to disappear towards the twentieth day, leaving in their place little reddish cicatrices. Swelling of the parts sometimes persists for a long time, but can be diminished by exercise and massage. The hair rapidly grows again.

and almost entirely masks the little smooth cicatrices left by the cautery. This is one of the chief advantages of this method.

Whatever the degree of firing and the mode employed, a certain period of rest is needed. As a rule, after the lapse of the first or second week, it is well to exercise the animal daily for twenty minutes to half an hour. If possible the animal should be sent to grass at the end of two or three weeks, the rest given extending from one up to three months. In injuries to the tendons in spavin and some other conditions such rest is absolutely essential.

The operation may be complicated in various ways. Thus the skin may be divided and a gaping wound produced; capillary hæmorrhage may result, or the fired surfaces may be torn. Such results may, however, be avoided by reasonable care. Loss of skin and the formation of large cicatrices following too severe a use of the iron are more serious. When such results threaten means must at once be taken to prevent sloughing. The frequent application of the cold spray is one of the most common methods; if conjoined with an antiseptic lotion it is more useful, it cleanses the parts, and removes the irritating exudate which exaggerates the inflammatory symptoms. Lotions and astringent compresses moistened with weak acetate of lead, Goulard's extract or alum solution have also been recommended. Lukewarm antiseptic baths followed by dusting with iodoform or a mixture of iodoform and tannin are preferable. Nocard highly recommends spraying with an ethereal solution of iodoform. He says that it abolishes suppuration, and checks the microbic infection of the wounds resulting from the removal of the scabs. Hæmorrhage resulting from puncture of a vein or arteriole by the needle is without danger. It either ceases spontaneously, or can be stopped by introducing into the little cutaneous puncture a small tampon of wadding, or by applying a compress dressing.

Subcutaneous cauterisation, recommended in Italy, appears to present no marked advantages, and may be dismissed here with the statement that the skin is first divided, the edges held apart, and the globular-headed iron applied directly to the deep-seated structures thus exposed. In times past it was not unusual to fire sound horses with the idea of preventing the formation of ring-bones, spavins, etc. Needless to say, such a course is not only inhuman but absolutely useless.

CHAPTER IX.

METHODS OF UNITING WOUNDS.

Healing by first intention with the formation of a mere linear cicatrix is the surgeon's ideal, but can only be attained when the margins of the wound are accurately united and held steadily in position. Given these conditions, healing by primary intention is assured in an aseptic wound. Apposition is best effected by sutures, *i. e.* by drawing together the edges of the wounds by stitches; though some wounds may be united by the use of adhesives like collodion, wound gelatine (either alone or with the addition of oxide of zinc), sticking-plaster, emplastrum adhæsivum, pitch plaster, or strips of fabric fastened to neighbouring parts by common glue.

The wound is disinfected, the hair shaved from the neighbouring parts, the skin dried, and slender strips of plaster applied at right angles to the long axis of the wound. Once these firmly adhere, the edges of the wound are pressed firmly together, the free ends of the strips of plaster carried straight across with some tension, and fastened on the opposite side. Another method is to fix strips on either side alternately, and by drawing in opposite directions on opposing pairs to bring together the lips of the wound. A third method consists in fixing a somewhat broad strip of plaster along each edge of the wound and uniting the strips by sewing. Dégive uses rubber bands to draw together the strips in place of sewing.

In using collodion the edges of the wound are pressed together with the fingers, the collodion applied thickly, and the wound held until such time as the dressing has had time to dry. Strips of linen may also be saturated with collodion, and applied rapidly across the edges of the wound whilst the lips are pressed together.

In animals, however, this method of uniting wounds can only be used in rare instances, partly because of the presence of hair, partly because of the animal's resistance and the violent contraction of its muscles, especially of its panniculus muscle. If plaster is applied, even in broad strips, over the hair it soon looses its hold, and the wound gapes or the continuous pull tears out the hair with a similar result. When the hair is shaved and the strips applied directly to the skin, they are apt to become detached by the rapidly growing new hair before firm union of the wound surfaces has taken place.

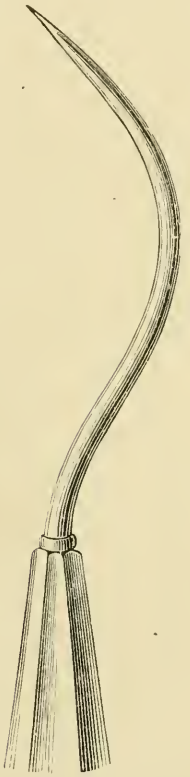


Fig. 153.—Largu's suture needle; metal handle for aseptic surgery.

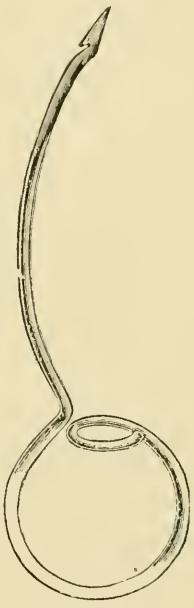


Fig. 154. De Mooij's suture needle all in metal, for aseptic surgery.

The method of uniting wounds by small hooks, pincettes, etc., though widely used in human surgery, is useless in our patients.

Bandages, however, can be employed with greater success. In many positions, for example in the extremities, union can be effected by using bandages without the help of sutures; but the method is never thoroughly reliable, for which reason bandages are best utilised to reinforce or assist sutures, to neutralise excessive tension and tearing out of the threads, or to check movement, and thus ensure the most favourable conditions for union.

Little attention was formerly given to the proper use of sutures, and it was thought that in animals wounds seldom healed by primary intention, the reason being that operators took little pains to ensure antisepsis, and consequently the sutures rapidly tore out. All this is now changed. Many of the contra-indications formerly given are no longer recognised. In times past only fresh wounds were sutured, and old wounds were always "freshened" before being united. It is true that fresh wounds present the most favourable conditions for healing by first intention, but it is also possible to bring together granu-

lating surfaces and effect healing. Furthermore, bruised or torn wounds were not sutured, though even they may heal by primary intention, provided the margins are not absolutely crushed, have not lost their vitality, and have not been cut off from the circulation. Tissues in which the circulation has been reduced to an absolute minimum may still retain their vitality by means of the "plasmatic" infiltration until circulation of blood by the formation of new blood-vessels becomes possible, and small fragments of dead tissue can be cast off without imperilling primary union.

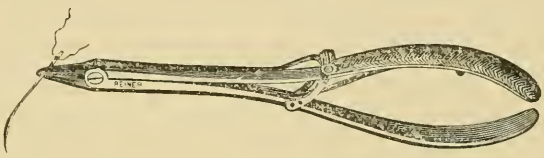


Fig. 155.—Needle-holder (Reiner's).

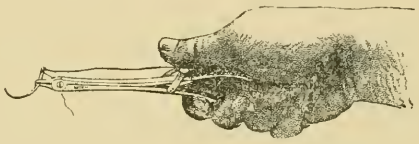


Fig. 156.—Showing method of using needle-holder.

Deep wounds were left open because retention of discharges was feared. By using drainage-tubes, however, these can nowadays be united without bad consequences. On the other hand, great tension, especially in wounds with loss of substance, contra-indicates the use of sutures, which would rapidly cut out, and would therefore only be a drawback. Moreover, those portions of the lips of the wounds enclosed within the threads might themselves die, increasing the loss of substance.

It is inadvisable to remove irregular fragments from the edge of the wound—to "regulate" the wound, as the old school had it,—because although the lips thus more closely approximate to a straight line, sound tissue may be removed, the wound is enlarged, and the tension on the sutures must be increased.

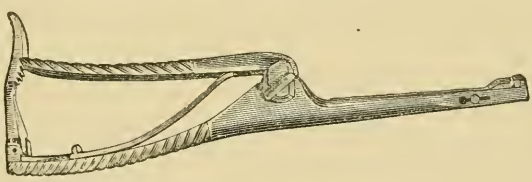


Fig. 157.—Needle-holder (Hagedorn's).

Sutures are therefore only contra-indicated when marked tension exists, or when the wound shows septic infection or is offensive. Almost all wounds in animals are more or less infected, but by the free use of antiseptics such infection may be reduced to a minimum.

For suturing wounds we require needles and various kinds of suture material. Needles are either simple or provided with a handle, and may be straight or curved; some of the latter again

being curved throughout, and representing the segment of a circle or ellipse, others half curved, only the anterior half being curved, the posterior being straight. The last two are the most useful. Some needles are curved in the plane of their greatest thickness in order to ensure greater stiffness. They are, however, less easily grasped and directed. In modern needles the point is almost always lancet-shaped and double cutting. Numerous complicated arrangements have been introduced to facilitate threading, but have not met with much popularity. One of the most practical is shown in Fig. 158. Compound or handled needles are fixed in a handle and carry the eye close behind the point (Fig. 153). They are passed through the edges of the tissue until the eye is exposed, and then threaded and withdrawn, bringing the thread with them. When using small or sharply curved needles, working in the depths of a wound or suturing firm tissues, a needle-holder (Figs. 155 to 157) is almost indispensable. In case of need a pair of dressing forceps efficiently replaces the special needle-holder.

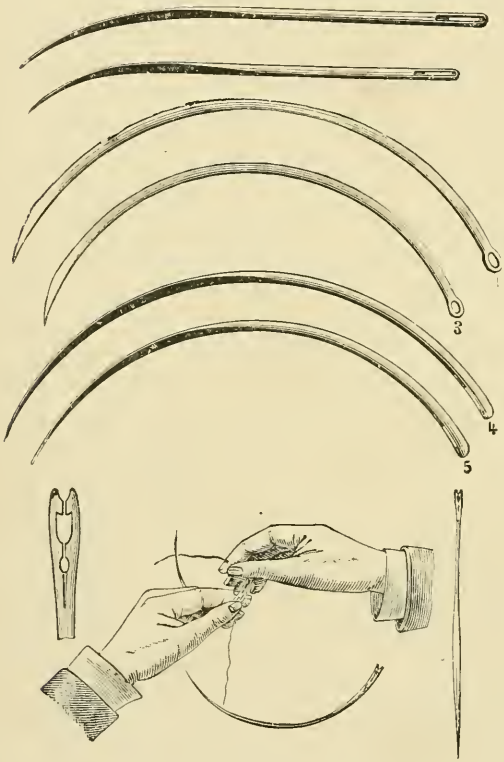


Fig. 158.—Suture needles.

The chief suture materials are aseptic silk, silkworm gut, and catgut, none of which impede healing. Catgut is very useful, as it becomes absorbed after a time, and therefore the stitches require no further attention; but sometimes this occurs very rapidly, with the result of releasing still ununited portions of the wound and allowing the lips to open. To overcome this difficulty, bichromatised catgut, which only dissolves very slowly, is employed, but silk is preferable for all skin wounds, and can even be used for abdominal operations, as if properly sterilised it does not irritate and becomes encysted or disappears. A number of different sizes must be provided of each of these materials. Silkworm gut is very smooth, non-absorbent, and unirritating; it is

largely employed for suturing skin wounds where immediate union is of much importance. Soft metallic wire and prepared horsehair are also used. To preserve silk and catgut in an aseptic condition the special holder shown in Fig. 82 is very practical.

General Directions for inserting Sutures.—Before inserting sutures bleeding must have completely ceased. Capillary hæmorrhage is sometimes stopped by the sutures themselves, the bleeding surfaces being pressed together; but any large bleeding vessels should be ligatured or twisted, otherwise the object of suturing will be defeated. All foreign bodies, and not merely those of a macroscopic character like fragments of dirt from the wounding body, or of crushed tissues, clots of blood, etc., but also organisms which would set up inflammation and suppuration, must be removed. This is effected by shaving the hair from around the wound and wiping and rinsing the parts carefully. Wounds are in the most favourable condition for union when all bleeding has ceased and the surfaces are covered with a thin film of clear serum. Although in human surgery only sterilised, that is, aseptic, dressings and sterilised water are used, it is much better in animals to use some antiseptic, because in their case wounds are much oftener infected from the beginning, and have usually been inflicted a considerable time before coming under the surgeon's notice.

The preceding measures having been carried out, the lips of the wound are approximated, and a decision formed as to the number, kind, and arrangement of the sutures to be used. The number, of course, depends on the size of the wound, and the kind on the tissue to be united—whether it be skin, bowel, muscle, etc. The first suture is best inserted where the parts are most out of line. In very long wounds a series may first be placed at somewhat long intervals, so as to ensure the approximately correct apposition of the edges before proceeding to final closure.

Sutures must be so inserted as to bring the lips of the wound into close contact at all points, and it is better to err on the side of using too many than too few. In mucous membranes, bowel, etc., more sutures are necessary than in the case, say, of skin. Their distance apart ranges between three sixteenths and three eighths of an inch. The points of entrance and margins should be at equal distances from the borders of the wound, and in the case of the skin not less than three eighths of an inch. The old rule, however, that the needle should be inserted at a distance from the edge equal to the depth of the wound, so that the surfaces should touch throughout their extent and no open space remain below the suture, is not always to be followed; one is

sometimes obliged to seek primary union of the skin, leaving union of the depths to follow by granulation. A drainage-tube may then be inserted to facilitate discharge, care being taken to select the most dependent point for its exit; but considerable doubt has been thrown on the efficacy of drainage-tubes, and after being replaced by gauze, plaited horsehair, etc., they have been finally abandoned by a good many operators. They are, however, useful in properly selected cases. Retention of discharge must be carefully prevented, because not only would such discharge thrust apart the deeper surfaces of the wound, but it would greatly favour the multiplication of micro-organisms.

When rapid healing of deep wounds is of great importance, the deeper seated structures should be united with aseptic material, and the threads cut short before the skin wound is closed. These "buried sutures," if aseptic, cause neither irritation nor suppuration. In penetrating wounds involving the peritoneum the serous surfaces must first be brought together, then the muscles, and finally the skin; similarly in extensive wounds of tendon sheaths and joints, the tendon sheath or capsule of the joint is first to be united and afterwards the skin.

To avoid displacing the margins sutures should be inserted at right angles to the long axis of the wound. They should merely bring the surfaces into contact and hold them together; the most frequent error in this respect is to draw them too tight, causing them to cut out or even to produce local necrosis of the lips of the wound. They should be left in position until the new tissue has become sufficiently firm. Primary union occurs within three to five days or not at all; the changes in the wound after this time only influence the firmness of the cicatrix. The usual direction, to remove sutures between the fourth and sixth days, without reference to the size, degree of tension, mobility, etc., of the wound, is apt to be followed by tearing apart of the newly formed, tender tissues within the succeeding twenty-four hours, necessitating a fresh operation. Some practitioners seem to dread a trifling amount of cutting, but it is of no particular consequence. When sutures threaten to cut out, either from being drawn too tight or from local swelling, it is often advisable quickly to insert a few fresh ones rather more distant from the edges, so as to avoid the need for entirely resuturing the parts, which is not always successful. Sutures of aseptic material may be left eight or even fourteen days in position without causing suppuration.

Sutures may be divided into uniting or coaptative, which serve to draw wounds together, and tension sutures or sutures of relaxation, which counteract the pull exercised by the tissues and thus relieve tension on the uniting sutures.

The greater number of special sutures described from time to time have only an historical interest.

Skin Sutures.—The most important and the most commonly used is the plain interrupted suture shown in Fig. 159, which can be employed in almost all cases. It is made by passing a thread through the opposing lips of the wound, drawing the free ends together, and tying them firmly towards one side of the wound. The needle carrying the suture is

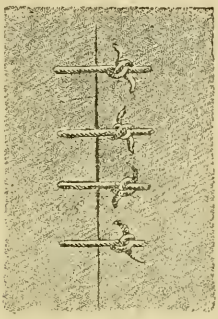


Fig. 159.—Interrupted suture.

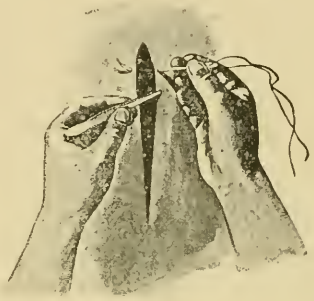


Fig. 160.—Inserting the suture.

grasped in the right hand, the thumb on the concave, the index and middle fingers on the convex side (Fig. 160), or a needle-holder may be used (Fig. 156). The edges of the wound are successively raised with the fingers of the left hand or with forceps, and the needle passed through them first from without inwards, then through the opposite lip from within outwards (Fig. 160). A better method, however, is to raise both lips together, producing a somewhat deep fold, through the upper part of which the needle is passed with a single thrust (Fig. 161). This secures a larger surface for union; when only the extreme edges of the skin are brought into contact, rapid union is much less certain. The comparative poverty of blood-vessels in the skin of animals as compared with that of man explains the difficulty with which skin surfaces alone unite, or when united hold together under tension. The appearance of a wound sutured in the above-described manner is certainly somewhat unsatisfactory, but there need be no fear of the fold remaining. As soon as the threads are absorbed or removed the fold disappears, leaving only a narrow cicatrix. To relieve tension in wounds so united it is generally desirable to insert one or more "relaxation" sutures.

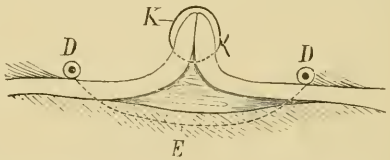


Fig. 161.—Methods of suturing to secure largest possible surface for adhesion. *K*. Interrupted suture. *D, D*. Suture of relaxation.

Sutures may be tied successively as inserted, or tying may be deferred until all are in place. In animals it is usually best to tie them as one proceeds. The fear of them tearing out when the animal rises is unjustified, provided a sufficient number have been used and one or more "relaxation" or "tension" sutures have been inserted. Bayer always sutures wounds left after the removal of elbow tumours (capped elbow), and although the sutures are exposed to great strain on the animal rising he has never seen them tear out. In this country, of course, such tumours are not infrequently removed in the standing position under local anæsthesia, and the danger of tearing out is therefore comparatively trifling.

The knots should lie to one side or other of the line of union, not on the wound. The threads are cut off short. When the lips of the wound are thin they often tend to turn inwards when sutured and to delay union. This cannot take place where a fold is raised, but should it occur it can easily be rectified by raising the edges with dissecting forceps and holding them in this position until the sutures are tied.

In tying a surgical knot the free end of the thread is twisted *twice* around the fixed end when forming the first portion of the knot. To remove sutures the knots are grasped with forceps, the loops lifted sufficiently to allow the points of the scissors to be slipped gently beneath, and the threads cut and withdrawn. Should a thread stick, the lips of the wound may be supported with the free hand whilst the thread is being extracted. As already remarked, catgut is completely absorbed, so that only the portion of the suture outside the wound requires removal.

The continuous suture or glover's stitch (Fig. 162) is, after the interrupted (Fig. 159), probably that most commonly employed. It begins at one end of the wound like an ordinary interrupted suture. After tying the first suture the thread, however, is not cut off, but is carried obliquely across the lips of the wound and reinserted on the opposite side, the needle being passed once more at right angles through the edges of the wound, which must be held in close apposition. In this way the thread passes continuously from one end of the wound to the other. At the point where it finally emerges it is cut off and tied at one side of the wound, so that the beginning and end resemble an ordinary interrupted suture. Another method consists in leaving the ends free until the suture is complete, when they can be knotted together, forming a long loop. In removing this suture the thread is divided at each loop, and the fragments withdrawn one by one. The glover's stitch has the advantage of being rapidly inserted, but many regard it

with disfavour. Despite the greatest precautions the wound cannot always be maintained aseptic. If the glover's stitch has been used, and it should become necessary to relax or remove a thread here and there, the whole wound reopens.

In the blanket or button-hole stitch (another form of continuous suture) the needle, after traversing the lips of the wound, is carried under the slack of the thread, so that the loop of each stitch as it is tightened is maintained at right angles to the edge of the wound, whilst the intermediate portion lies parallel to it.

The pin suture, also known as the twisted or figure-of-8 suture (Fig. 163), though much praised by certain operators is less often used than formerly. It is employed where the edges of the skin are very thin and without much subcutaneous tissue, as, for example, in the eyelid. wing of the nostril, skin of the cheek, lip, etc., and where the margins

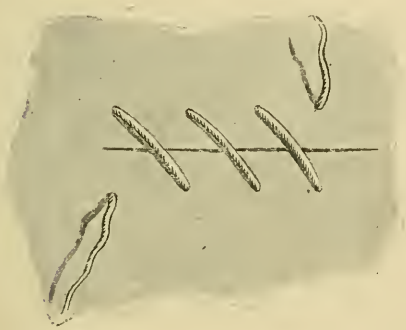


Fig. 162.—Continuous or glover's stitch.

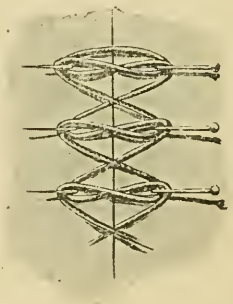


Fig. 163.—Figure-of-8 or pin suture.

show a tendency to roll inwards. The pin then acts as a support for the edges of the skin. The pins are usually from one and a half to two inches in length, and parallel sided. They should be flexible, and may be of brass, copper, silver, etc. Ordinary pins, however, are very commonly used. They are sometimes inserted with a special instrument which holds the pin in a short tube and, by means of a pear-shaped handle like that of an awl, permits greater power to be exerted. The pins are passed at some distance from the edges of the wound, and a thread wound around the free ends in a figure-of-8. Where several pins are inserted in series one thread may be used for securing the whole, as in Fig. 163; in other cases a separate thread is employed for each. When secured the points of the pins are cut off with powerful cutting pliers. In removing pin sutures the margins of the wound should be pressed gently together with the fingers of one

hand, when the threads can be cut and the pins removed. Threads glued to the skin by discharges may, if aseptic, be left in position.

Another form of suture comparatively little employed is the so-called shoemaker's stitch. It is used in removing hernial sacs, new growths, etc. An awl-like needle carrying a long thread is passed through the new growth, and the loop is cut, leaving the growth transfixed with two threads. By tightly tying together the free ends of these threads on opposite sides the circulation in the peripheral portion of the growth is stopped, causing the part to become necrotic and fall away. By using a series of such sutures large growths may effectually be removed.

Of tension sutures or sutures of relaxation there are several varieties. Ordinary interrupted sutures may be used for this purpose if more widely spaced and inserted further from the edges of the wound and to a greater depth than usual (see Fig. 164).

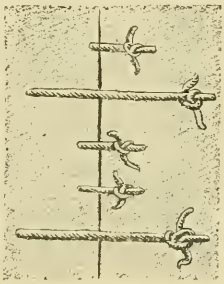


Fig. 164.—Ordinary deeply placed interrupted sutures used as sutures of relaxation.

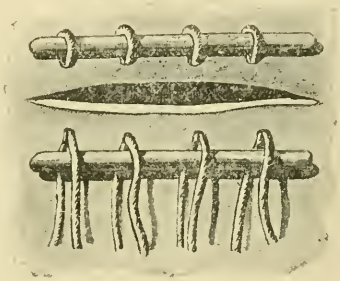


Fig. 165.—So-called "quilled" suture.

To equalise and distribute pressure, thus preventing the stitches cutting through the skin, the suture shown in Fig. 165 is often used. It is formed by passing a number of double sutures through the lips of the wound in such a way that the loops lie on one side, the free ends on the other. A small cylinder of any kind, like a quill or roll of gauze, is then slipped through the loops; the free ends are drawn tight and tied over a similar cylinder inserted on the opposite side. The cylinders extend for some distance beyond the ends of the wound.

It happens, however, at times that animals lie on the part so secured, and the cylinders are apt to cause pressure necrosis, making it necessary to remove the whole of the sutures, despite their still being required. A modification was therefore introduced in which small rolls of gauze are employed for each complete suture, allowing one to

be removed without disturbing the rest (Fig. 166). As, however, these rolls of gauze become hard when saturated with blood or discharge, they may advantageously be replaced with small pieces of disinfected rubber tube, which can easily be cleaned, and which yield slightly when swelling occurs. In long wounds comparatively thick drainage-tubes may be used, sufficiently long to extend beyond the ends of the wound, thus reproducing the old form of suture shown in Fig. 165. This secures the advantages of greater cleanliness and a certain yielding quality, which permits of the longitudinal tube adapting itself to irregularities of surface, and thus exercising more regular pressure. Should a suture threaten to cut, the drainage-tube may be divided at any point, and the compound suture converted into interrupted ones.

Another form of tension suture is shown in Fig. 167. The free ends of the silver wire are passed through small oval plates of any light

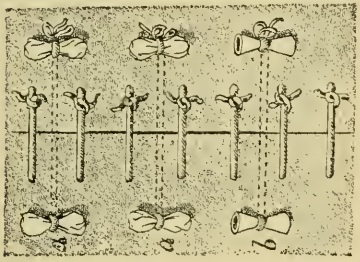


Fig. 166.—Interrupted sutures combined with sutures of relaxation.

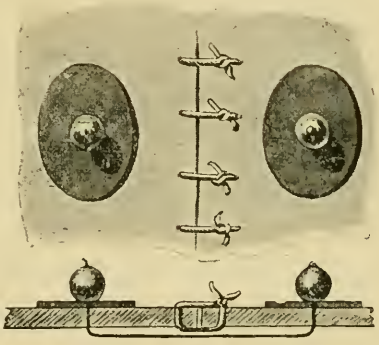


Fig. 167.—Tension suture in position.

metal like aluminium, and secured by perforated shot slipped over the wire and compressed by pliers. Occasionally the plates are omitted, and small leaden shot or glass beads alone used. The suture is then secured by forming a rather large knot above the bead at each end.

Bowel Sutures.—For uniting the walls of the bowel many complicated methods have been proposed, some of which certainly were of value in pre-antiseptic days, but are now discarded. Possessing as we do suture materials which may safely be abandoned in the abdominal cavity without setting up suppuration, peritonitis, etc., many special precautions are now unnecessary. The sutures hereafter described are those most frequently employed and easiest to use. In devising a bowel suture, it must be borne in mind that mucous membrane will not readily unite with mucous membrane on account of the continuous secretion occurring, and that the surfaces to bring together

are either the muscular or serous coats, the latter of which shows a great readiness to adhere and unite. Sutures must also ensure perfect closure of the bowel wound and absolutely prevent bowel contents exuding. They should, therefore, be inserted about every one eighth of an inch. On account of the thinness of the walls slender needles are necessary. Special fine curved needles or fine sewing needles can be employed. Aseptic silk is probably the best sewing material; catgut is less adapted for the purpose as it is sometimes too

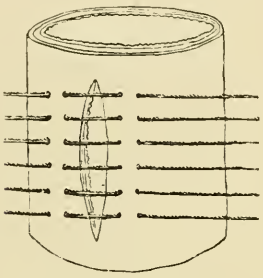


FIG. 168.—Schema of Jobert's suture (now abandoned).

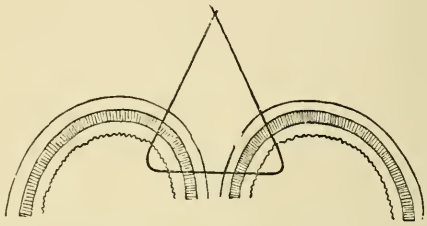


FIG. 169.—Schema showing Jobert's suture in section.

rapidly absorbed, the sutures yielding before the union of the surface has occurred. To prevent this, catgut rendered partially insoluble by the action of chromic acid has been introduced, but boiled silk has no such disadvantage and serves every purpose.

The first and simplest form of suture was Jobert's. The needle was first passed through the serosa at some distance from the wound,

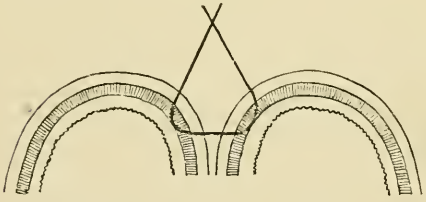


FIG. 170.—Lembert's bowel stitch.

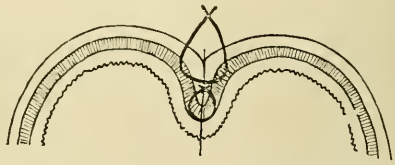


FIG. 171.—Lembert-Czerny bowel stitch.

penetrated the entire thickness of the bowel, and emerged close to the free border of the wound. The opposite lip of the wound was transfixed in a similar way. The ends were then knotted together and cut off (Fig. 168). This suture brought the serous coats into apposition, as shown in Fig. 169, but had the disadvantage that the threads passed through the lumen of the bowel, and might thus convey septic material from it into the peritoneal cavity, producing infection and inflammation in the track of the suture, resulting later in peritonitis.

For this reason Jobert's suture was discarded in favour of Lembert's, in which the threads are passed in a similar way but do not penetrate the mucous membrane, only extending to the muscular coat (Fig. 170).

Czerny reinforces Lembert's stitch by interrupted sutures uniting the mucous membrane, Lembert's stitch being employed to bring the serous surfaces into apposition ; he thus unites the edges of the wounds twice. The first series do not penetrate deeper than the submucous tissue. This system, however, is difficult to carry out. It is much easier if the suture begins and ends in the serous coat ; the knots then lie externally between the two surfaces of peritoneum.

In isolated instances it may be desirable to unite the mucous membrane itself. In such cases the first half or more of the incision should be sutured from within, and the knots tied on the inner surface. As, however, the wound becomes smaller this is no longer possible, and the remaining half of the wound must be united with sutures penetrating to the submucous coat but tied externally. The whole of the wound having thus been closed, the serous surfaces are brought together in the manner above indicated. It might be advisable in cases where other tissues lined with mucous membrane are divided, as for instance the eyelids, cheeks, salivary or urinary ducts, the œsophagus or bladder, to proceed as above, uniting mucous membrane to mucous membrane. The apposition of secreting surfaces should be avoided.

Tendon Sutures.—In man recently ruptured tendons are united by deep catgut or reindeer tendon ligatures left in position. In such case the paratendinous connective tissue is turned inwards like the serous coat in the last instance, because it contains the vessels and most readily unites. The needle is inserted about a quarter of an inch from the divided end of the tendon, carried (say) downwards beneath the superficial layers of tendon fibres, brought out through the torn surface, and passed through the opposite end of the tendon after a similar but reversed fashion. The ends are knotted and cut off. If necessary, a complete ring of sutures may thus be inserted around the tendon, after which the outer wound is closed. It is often extremely difficult to insert sutures because the muscles retract the ends of the tendon to a considerable distance. The divided ends may, however, often be approximated by placing the limb in a special position, in which it must afterwards be fixed by the application of a dressing, plaster bandage, or splint, etc., secured as circumstances will permit. This procedure might be imitated in small animals. In the present condition of our science, however, it is practically impossible to insert sutures in those tendons which are most frequently ruptured,

viz. the flexor pedis perforans or perforatus in the horse, because these act not only as prolongations of the flexor muscles, but as a weight-carrying apparatus, and the dead load which rests on them is much greater than any sutures could bear, even though reinforced by unyielding dressings and favoured by immobilisation of the extremities in the best position for a number of weeks.

Nerve Sutures.—In suturing nerves one end of the nerve-sheath is united to the opposite end, the suture not penetrating beyond the paraneurotic tissue.

CHAPTER X.

PHLEBOTOMY, SCARIFICATION, AND TRANSFUSION.

By phlebotomy is meant the surgical opening of a vein for the purpose of removing blood. Although bleeding is almost invariably practised on veins, arteries may be utilised for the same purpose, and the old term blood-letting included venesection or phlebotomy and arteriotomy. Bleeding from capillary vessels is usually effected by scarification or the application of leeches.

Bleeding may be divided into general and local. General bleeding consists in removing a large volume of blood with the object of lowering blood-pressure throughout the body; local bleeding, on the other hand, is undertaken to reduce the quantity of blood in the part operated on or in its immediate vicinity, *i. e.* to improve the conditions in a circumscribed area.

Bleeding from arteries and capillaries is much less commonly performed than from veins, and venesection, formerly practised in the most widely differing localities, tends to become more and more confined to the jugular vein. In former times bleeding was popular in all acute and feverish conditions, and was so excessively practised that a reaction naturally set in. It has now almost fallen into desuetude, a result accelerated and confirmed by the entirely different views now held as to the value of general bleeding. In bacteriological laboratories, of course, bleeding is a necessary preliminary to the preparation of protective sera, and is also resorted to for obtaining blood for microscopical or bacteriological experiments. The periodical bleeding of animals in spring to keep them in good health is still practised in a few parts of the country, but is rapidly

dying out. The innate vitality of ancient superstitions is well illustrated by its having survived so long.

The chief results of blood-letting are as follows:

1. The reduction in quantity of the circulating fluid is at once followed by diminished blood-pressure in all the vessels and changes in the circulation favourable to the relief of local congestion. Congestion in important organs like the lungs and brain, and possibly also the sensitive laminæ of the feet, therefore constitutes the chief indication for bleeding.

2. The blood withdrawn contains a large quantity of nutritive material and blood-corpuscles, both of which are of great importance to the organism when struggling with microbic infections; in such diseases, therefore, blood-letting is seldom advisable. As it is also known that inflammatory processes in the body most commonly result from infection, the fact renders blood-letting still more questionable as a means of combating inflammation.

On the other hand, a certain amount of infective or toxic substances is also removed with the blood, but as general bleeding weakens the patient, and as active resorption from the great body cavities follows, it may happen that a greater amount of injurious material is eventually absorbed than is removed from the circulation. In general, therefore, bleeding is seldom resorted to in infective or toxic diseases. The good effects sometimes obtained in lumbago and laminitis may perhaps be referred to the above causes.

3. As mentioned, active absorption from the tissues and body cavities follows bleeding, and the fluid constituents of the blood are thus replaced. This explains the value formerly attached to the practice as a means of promoting resorption. In opposition to this is the fact that the proportion of water in the blood is thereby relatively increased, and with it the tendency to fresh exudation. Experience shows, in fact, that little can be expected of bleeding in this direction.

4. Bleeding is followed by a temporary increase of tissue metabolism, as shown by augmentation in the quantity of nitrogenous compounds and phosphoric acid voided in the urine. Such a result can scarcely be interpreted as favouring recovery.

It would appear that bleeding plays no great therapeutic *rôle*, and when we recall that it is contra-indicated both in extreme youth and age, in constitutional weakness, pregnancy, etc., there is little wonder if it is now comparatively little practised. Its most important indications are in dangerous conditions resulting from marked disturbance of circulation in important organs like the lungs and brain.

It is also valuable in other diseases like laminitis and lumbago, in which, however, its exact *modus operandi* is obscure.

At the present day horses are almost invariably bled from the jugular vein; formerly it was the custom to bleed from the subcutaneous thoracic vein in diseases of the chest, from the mammary vein in diseases of the udder, from the transverse facial vein in diseases of the eye, and from the digital vein in diseases of the foot, but experience slowly convinced operators that no advantage was thus gained. The jugular vein is now almost invariably chosen because it is easy to find, conveniently situated as regards height, etc., and while blood-pressure within it is low, a considerable volume of blood may be obtained in a short time. The spot chosen is the junction between the upper and middle thirds of the neck, where

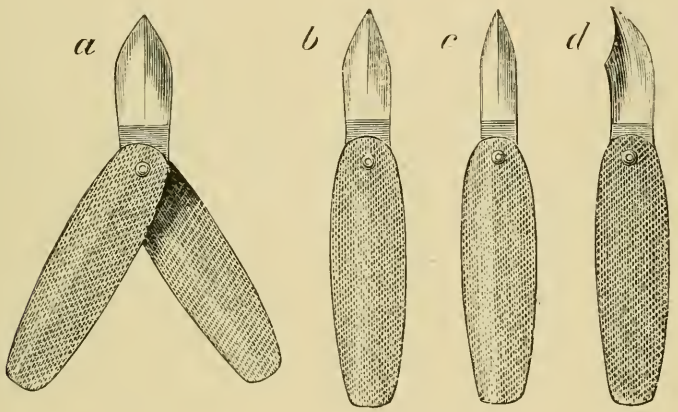


FIG. 172.—Bleeding lancets.

the subscapulo-hyoideus muscle intervenes between the vein and the carotid artery, which is therefore less likely to be injured.

The average quantity of blood abstracted at one time is, in the ox, 10 to 16 pints, the horse 8 to 12 pints, the pig 1 to 1½ pints, sheep ⅔ of a pint, and dog ½ a pint, in fowls 2½ to 10 fluid drachms; individual peculiarities, however, must be taken into account in each case.

INSTRUMENTS.—The simplest instrument is the lancet (Fig. 172). It consists of a thin oblong fragment of steel, the upper third ground to an extremely keen double cutting edge. The whole is enclosed between two scales which protect it when not in use. Several forms are used, the varieties of which are shown in Fig. 172. The English lancet (*a*) has a relatively obtuse point; the German (*b*) is somewhat more acute; in the Italian (*c*) the blade is narrower from the commencement, and the cutting edge relatively long and slender; *d* is

the sabre-shaped or abscess lancet, having one convex and one concave cutting edge.

To bleed with the lancet, though apparently easy, requires considerable practice; the varying thickness and resistance of the skin in different animals making it difficult to judge of the exact amount of pressure required to open the vein without transfixing it.

For this reason other instruments have come into use. The simplest of these is the fleam (Fig. 173). The handle extends some-

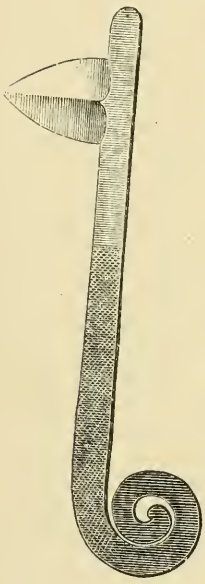


Fig. 173.—Simple fleam.

Fig. 174.

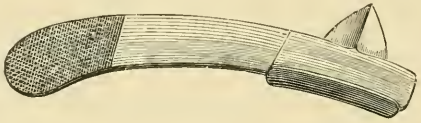


Fig. 175.

Figs. 174, 175.—Fleams.

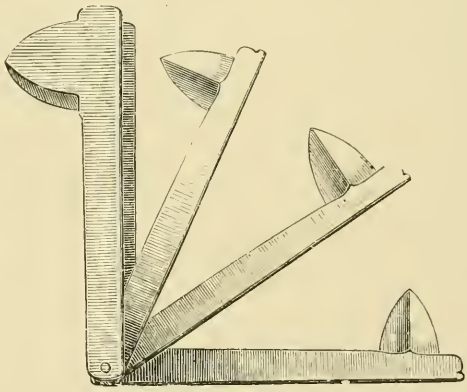


Fig. 176.—Case of fleams.

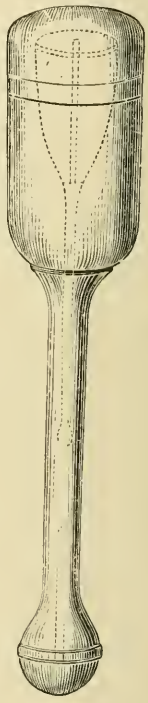


Fig. 177.—Blood-stick.

what beyond the insertion of the actual cutting part, and is intended to prevent the instrument entering too deeply. Sometimes the back of the handle is provided with a broad surface (Figs. 174 and 175) on which the blow of the blood-stick is delivered. Combined fleams having a number of blades in one setting are also common (Fig. 176). The fleam is caused to penetrate the vein by a sharp blow from the hand or blood-stick (Fig. 177). With the latter the necessary force can better be estimated, and the inconvenience of either failing to penetrate the vessel or completely transfixing it equally avoided; in

delivering the stroke the arm should not be moved as a whole, but only from the elbow.

Spring fleams (Figs. 178 and 179) are intended to overcome the foregoing difficulty. They always cut to a given depth, and produce a wound of given size. The case of the fleam is provided with an opening (*C*) for the passage of the fleam (*F*), which is withdrawn into the case and set by drawing back the cocking lever (*A*), leaving the plate (*C*) free for application to the vein. Having placed the instrument accurately in position the operator depresses the trigger (*D*), releasing the fleam, which makes a rapid to-and-fro movement, dividing the skin and opening the vein. As the instrument is readily placed in position,

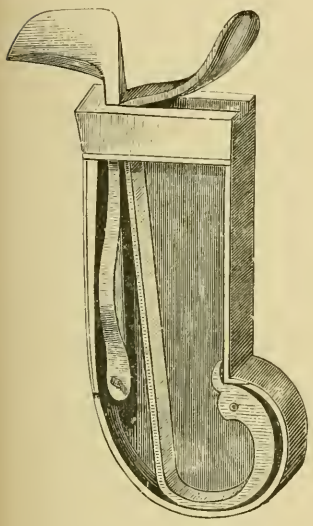


Fig. 178.—Spring fleam; old form.

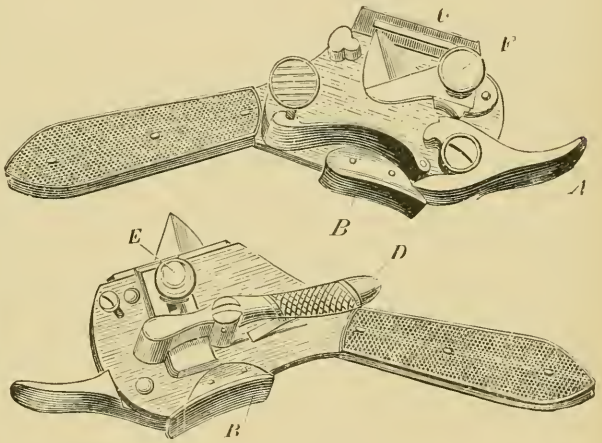


Fig. 179.—Spring fleam: later form.

calls for no skill on the operator's part, always cuts in the right direction and to the right length and depth, and can be regulated, it continues to enjoy some popularity, despite its being complicated and difficult to clean.

When bleeding oxen a bleeding string is required, *i.e.* a stout cord provided at one end with a ring. By passing the cord round the neck and through the ring and drawing it tight, temporary engorgement of the jugular is produced, which facilitates operation. Except for very heavy, fat animals it is not used in equine practice.

The blood should be received in a vessel of measured capacity, so that the amount removed may be accurately known.

The skin wound is almost invariably closed with a pin suture,

though it is difficult to know why the ordinary interrupted suture should so entirely have been displaced for this purpose. A word of caution is required against using hairs from the mane or tail to complete the suture, as was the old fashion. These hairs not infrequently formed the centre from which radiated an acute phlebitis.

The jugular vein lies in the "jugular furrow," formed above by the mastoido-humeralis and below by the sterno-maxillaris muscles. Beneath the skin and loose connective tissue lies the panniculus, which, though very thin in the upper portions of the neck, becomes over half an inch in thickness in the lower. In the upper half of the jugular furrow "the vein rests on the subscapulo-hyoideus muscle, which there separates the vessel from the carotid artery; but in the lower half the vein rests on the side of the trachea, and is in direct contact with the carotid, which lies above and slightly internal to it" (see Fig. 198). On account of this arrangement the best position for opening the vein without endangering the carotid artery is at the division between the upper and middle thirds of the neck.

Operation on the horse.—When using the spring fleam it is of little importance on which side the operation is performed, though some slight advantage accrues from selecting the right. The same is true of the lancet, but the fleam can be used most conveniently on the left. At the junction of the upper and middle thirds of the neck a small area of skin should be shaved and disinfected. This preparation minimises danger of phlebitis. (Figs. 180 and 181.) The horse is then bridled, and the head held exactly in the middle line by an assistant. Troublesome horses may be twitched, and the fore-foot on the side of operation may be lifted. When using the ordinary fleam the horse's eyes should be covered, because at the moment of striking the blow the animal is apt to start, defeating the operator; but of course this is not likely to occur in using the lancet or spring fleam. Having cocked the spring fleam, the operator stands beside the animal's shoulder, and with the thumb or fingers of the left hand compresses the vein, causing it to rise.

Should there be any doubt as to the exact spot to select, the pressure may be relaxed and repeated once or twice, when the rising and falling of the vein will render its position evident. Immediately it appears clearly the plate of the fleam is adjusted just over it and parallel with its long axis, the trigger is gently pressed, and the incision made. The fleam is then removed, and the vein compressed below the incision until the necessary quantity of blood has been taken.

If the vein has only been stabbed, the blood flows in drops

or in a very thin stream. In such case operation should not be repeated at the same point. Sometimes the blood at first flows in a thick stream, but soon diminishes in spite of continued compression. This is due to the skin having slipped to one side and covered the wound in the vein, or to a fragment of subcutaneous tissue having interposed itself. By slightly moving the skin or the horse's head, or by inserting the finger in the animal's mouth and so causing it to make chewing movements, the flow is restored. Occasionally the vein is opened over a valve, which falls into the wound and obstructs the stream.

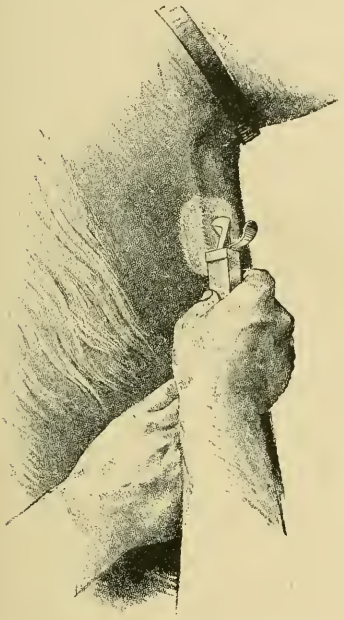


FIG. 180.—Bleeding with the spring fleam; off side.

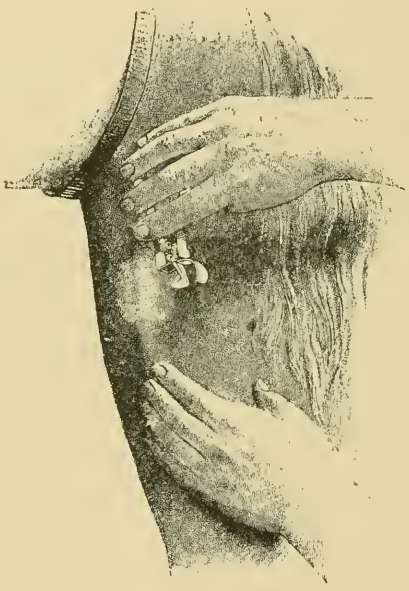


FIG. 181.—Bleeding with the spring fleam; near side.

Jets of bright red blood alternating with the darker stream show that the carotid has been injured, but as a rule the opening in that vessel is very small, and closes if pressure be removed, the external wound be sutured, and a dressing applied, though sometimes an aneurysm or aneurysmal varix results. Should the opening, however, be large the animal may even bleed to death, unless the carotid be immediately ligated. The vessel should then be firmly compressed by an assistant, the existing cutaneous wound enlarged for a distance of three to four inches, the panniculus and connective tissue divided, and the carotid exposed by blunt dissection. The artery should

be grasped with the fingers, drawn forward, freed from the nerves which accompany it, and, on account of the collateral circulation, doubly ligated. To prevent the vessel tearing through at the seat of ligation in consequence of continued tension it is divided between the ligature, and the ends allowed to retract. Care must be taken in separating the recurrent nerve and in cleansing the wound, as mechanical injury to the nerve or irritation produced by local suppuration may be followed by paralysis and "roaring." Other methods like continued compression of the artery and closure of the skin with sutures have been recommended. Compression might in isolated cases be followed by hæmostasis, but closure of the skin wound is dangerous. Experiment shows that a large hæmatoma usually develops, and pressure on the trachea may become so severe as to cause suffocation. Should the carotid be damaged the patient should be kept under observation. The accident, however, is rare.

Sometimes a small artery in the region of operation is divided, and gives the impression of the carotid having been injured. Injury of the vagus or sympathetic nerve seldom occurs. Perforation of the trachea can only be caused by gross carelessness, but if opened sufficiently for blood to enter the lungs, it might give rise to troublesome symptoms.

The low or even negative blood-pressure in the jugular vein renders that vessel specially convenient to bleed from, but at the same time entails a certain danger of air being aspirated into it, with suddenly fatal result. As a rule, even if the vessel be not compressed below the incision, sufficient blood flows from above to preserve a slight positive pressure. Should this pressure from above fail, however, as would happen were the vessel compressed *above* the wound, the down-rushing column of blood would aspirate air into the vessel, and a gurgling or bubbling sound be heard, indicating to an experienced operator the serious character of the accident. A deep inspiration is also followed by so rapid a rush of blood towards the heart as to dangerously favour the in-draught of air through the wound. Such accidents cannot well occur while the escaping stream of blood is well marked: they only happen after it slackens or ceases. Immediately the sound is heard the vein should be compressed as low down in the neck as possible, and attempts made to expel the air by stroking the vein from below upwards. After operation animals not infrequently lean against the manger or on the head-collar rope, and may thus compress the vein above the wound, with the result that air obtains entrance. For this reason the wound should always be sutured.

In many cases the entrance of small quantities of air produces no bad result; but in others the animal at once begins to sway to and fro, falls to the ground, shows violent dyspnœa, sweats, and may die in a few minutes.

Sufficient blood having been taken, the skin is closed either with a pin or interrupted suture. In the former case the pin is cautiously removed in thirty-six to forty-eight hours, the parts being supported with the fingers of the left hand whilst those of the right rotate and remove the pin. In closing the wound care must be taken not to exercise much traction on the edges, as this might cause separation of the skin from underlying tissues, and extensive extravasation. Similarly, if during bleeding the outer opening be obstructed, blood accumulates under the skin. Such extravasation would be of little consequence were it not that by compressing the vein it may lead to thrombus formation, and that it always supplies a favourable medium for the further development of the micro-organisms which almost inevitably enter. Failure to remember these facts, and to observe necessary cleanliness, account for most cases of suppuration and phlebitis and the train of complications which follow them.

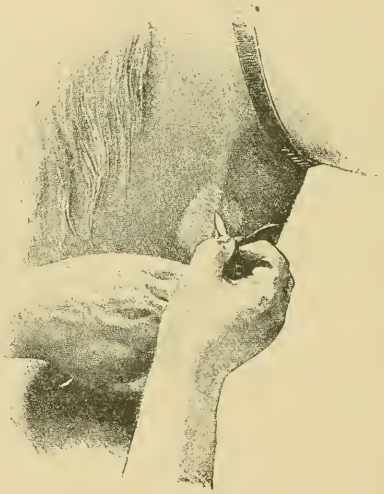


Fig. 182.—Bleeding with the lancet.

To prevent the animal injuring or infecting the wound, by leaning against or rubbing itself on the manger, etc., it should be secured by pillar reins or be tied up short. Nor should it be worked soon after bleeding, because the pressure of the collar on the vein or the rise in blood-pressure consequent on exertion may cause the lips of the wound to spring open.

In operating with the spring fleam on the left side, the instrument is held in the reversed direction—that is, with the blade pointed downwards (Fig. 181), or the vein may be compressed with the right hand and the fleam held with the left.

The right jugular is easier to open with the lancet (Fig. 182). The position of the operator is similar—that is, near the animal's shoulder. After wetting and smoothing the hair the vein is compressed

lightly below the point of operation and caused to appear distinctly. The incision is, as before, at the most prominent point and close to the operator's fingers, because here the vein is more or less fixed. The lancet is thrust inwards and slightly upwards, so as to produce a sufficiently large wound, though care must be taken not to absolutely slit open the vessel, as is sometimes done from over-anxiety. It then becomes difficult to stop the flow, and it may be necessary to ligate the vein, in addition to which there is danger of air entering the vessel. The incision should be in the centre line of the vein ; the upper (or posterior) aspect of the vessel must be avoided, as injury to the carotid artery may readily result from incisions in this direction.

In using the ordinary fleam (Fig. 183) the operator, standing opposite the animal's left shoulder, holds the fleam lightly between the index finger and thumb of the left hand, compresses the vein with the other fingers, and with a short, smart blow from the blood-stick, or failing this, from the edge of the right hand, drives the fleam into the vein. The fleam must be held exactly at right angles to the skin over the highest prominence of the vein, otherwise the vessel will be opened on one side or the instrument will slip past it.

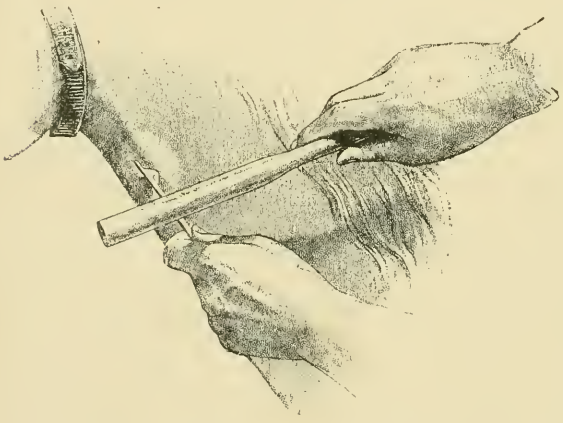


Fig. 183.—Bleeding with the fleam and blood-stick.

Dieckerhoff and Caspar have recently recommended a special trocar and cannula for bleeding. As this instrument had been used for some years for intra-venous administration of drugs, it occurred to them that it might be equally useful for withdrawing blood, especially where it was desirable to shield the withdrawn blood against contamination, as in preparing protective serum. The cannula has the great advantage over the fleam that it can be inserted several times at the same place. In operating, the vein is raised, the skin divided, and the vein exposed. The operator, standing on the animal's near side, then thrusts the cannula, carrying its shield, steadily into the vein for a distance of three or four inches, when bleeding follows. Some dexterity is required, but the method

is particularly useful for laboratory work, and avoids almost all the risks formerly appertaining to phlebotomy of the jugular. When the necessary amount of blood has been abstracted, a blunt trocar is inserted into the cannula to prevent air entering the vein, and the combined instrument withdrawn. The wound is dressed antiseptically and closed with a single suture, or may be left open.

In **cattle** the jugular vein is also opened. The animal's head is raised by grasping the horns and the eyes covered. The hair is clipped away from the seat of operation, the bleeding cord previously mentioned adjusted, and the vessel opened just above the point of compression by means of the fleam. The operator stands as in bleeding a horse. In small cattle one may even stand on the side opposite to that of operation and lean over the animal. This

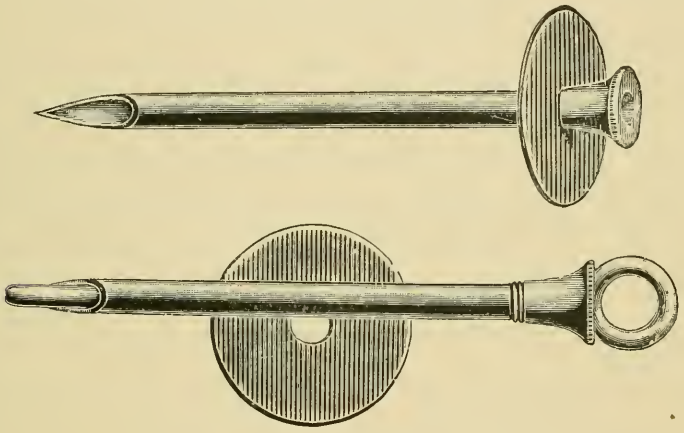


FIG. 184.—Dieckerhoff's bleeding cannula.

method has the advantage that the operator cannot well be struck by the animal when, as occasionally happens, it kicks in a forward direction. On account of the loose arrangement of the skin in oxen it is not necessary, though it is advisable, to insert a suture.

Bleeding from the mammary vein was formerly practised in diseases of the udder and of abdominal organs, but possesses no special advantage over bleeding from the jugular, while it is less easily carried out, and is dangerous to the operator, who has to work in a constrained position, and runs grave risk of being kicked by the patient. Moreover the wound is very liable to infection.

Sheep and goats may also be bled from the jugular, but as a rule the facial vein in the neighbourhood of the fourth molar is selected. It yields little blood, but this is by no means an unmitigated evil, as sheep and goats are very liable to serious symptoms after bleeding.

As in **swine** the jugular lies deep and is covered with fat, it is seldom opened, the lingual vein being preferred. A wooden rod being thrust between the teeth, the tongue is drawn forward, and the vein opened just over the frænum linguæ. Bleeding ceases spontaneously. In addition the transverse facial and anterior auricular veins are occasionally used. The internal saphena vein of the hind limb is also the seat of operation. It is compressed by applying a cord or bandage between the hock and stifle joint.

In **dogs and cats** the jugular, or the internal saphena vein of the hind limb, is the vessel usually indicated in text-books, but the operation is scarcely ever performed.

Arteriotomy.—The opening of an artery is very seldom resorted to. The operation is carried out in the same way as phlebotomy, or the artery is exposed, divided, and, at the conclusion of the operation, ligated.

Scarification.—Bleeding from capillaries is effected by scarification, cupping, or the application of leeches. Leeches are little used in veterinary surgery; the quantity of blood removed is trifling, the procedure troublesome and, considering the price of good leeches, costly. Scarification consists in making a number of comparatively shallow cuts in the tissue. It is seldom employed on account of suppuration and destruction of tissue frequently resulting. For cupping, which is also rarely resorted to, a scarifier or lancet and a cupping-glass are necessary. The scarificator (Fig. 185) consists of a metal box containing many small fleams and the mechanism for operating them. The blades can be raised or lowered by a screw, and the depth of incision regulated. The fleams, twelve to sixteen in number, are set and released in a precisely similar manner to the blades of the spring fleam previously described. Cupping-glasses are hemispherical in shape, with edges ground to a true surface. The centre is pierced by a small hole, and carries a short hollow stem to which a strong rubber ball is fixed. The scarificator is applied to the shaven and disinfected skin, released, and applied a second time at right angles to its previous position so as to produce cross cuts: the rubber ball on top of the cupping-glass is then compressed, the glass applied to the scarified area, and the ball released, causing a partial vacuum. When partially filled with blood, the glass is removed, emptied, and again applied until the necessary quantity of blood has been taken. A dressing is afterwards applied over the seat of operation.

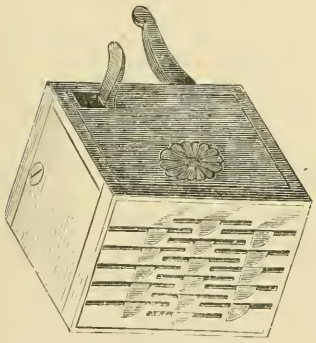


Fig. 185.—Scarificator.

In removing blood for the preparation of protective serum ordinary methods are unsuitable, because organisms may obtain entrance to

the stream of blood and the receiving vessel. The vein is therefore exposed, and a trocar provided with a rubber tube connection is inserted in it. The glass cylinder to receive the blood is closed with parchment paper, and covered with a moveable metal cap provided with an opening. All the instruments and apparatus are, of course, most carefully sterilised.

In use the parchment is pierced through the opening in the metal cap, and the rubber tube lowered into the cylinder so that the stream of blood comes as little as possible in contact with the air and forms no foam. Immediately the vessel is filled the tube is withdrawn, the cap turned round, and the opening in the paper thus covered.

Transfusion.—By transfusion is meant the conveyance of blood from one individual into the vessels of another. It is only employed where fatal exhaustion threatens in consequence of severe loss of blood or blood poisoning, especially such as follows the respiration of carbonic acid, ordinary illuminating gas, chloroform, etc. The instruments required are a knife, forceps, scissors, a cannula, and a glass funnel with rubber tube.

The healthy animal is bled into a tall vessel placed in water at blood-heat. The blood is then whipped until all fibrin is separated so that no clots may form, which might produce emboli in the vessels of the recipient. In the meantime a large vein or even an artery in the subject is opened, the cannula inserted, and some blood allowed to escape in order to expel all air from the cannula. The defibrinated blood having been filtered through fine linen is used to fill the syringe or funnel, care being again taken that no air remains in the instrument. The syringe or tube from the funnel is then connected with the cannula, and the blood passed slowly into the veins of the subject. This process is termed mediate transfusion.

After transfusion it sometimes happens that the body temperature falls, cyanosis and severe dyspnœa set in, followed by hæmoglobinuria, or even death. The cause of this intoxication is probably the presence of fibrin ferment in the transfused blood. To prevent this the blood is often conveyed direct from blood-vessel to blood-vessel by a connecting rubber tube. This operation is termed immediate transfusion. Apart from the difficulties of the process and the impossibility of controlling the quantity of blood introduced, there is considerable danger of the formation of clots. Considering its risks transfusion is nowadays practically abandoned, especially as it has been shown that the dangerous symptoms depend not so much on the want of blood as on the sinking of blood-pressure. The whole value of transfusion, therefore, lies in its providing a sufficient quantity of fluid for the heart to act upon.

Similar results may safely be obtained by intra-venous injection of ·6 per cent. watery chloride of sodium solution, to which has been added a few drops of carbonate of potash solution, or, still more simply, by subcutaneous injection of the same solution.

The process is most applicable to dogs. To prevent dangerous anæmia of the brain during the preparation of the solution, etc., the animal's head is allowed to hang over the edge of the operating table,

or the hind limbs may be lifted, the body enveloped in hot clothes, and ether injections given. Even after injecting physiological salt solution, heat must be applied to the body, and warm fluids like milk, etc., should be administered unless they can voluntarily be taken. Warm wine or beer beaten up with eggs, or warm milk with the addition of brandy, are also useful.

CHAPTER XI.

METHODS OF PREVENTING OR CONTROLLING HÆMORRHAGE—HÆMOSTASIS.

The first check to the flow of blood from a divided vessel results from the contraction of the elastic fibres and muscular coats and the mechanical closure of the bleeding orifice. The flow being checked a clot soon forms, which seals the aperture, partly by its contraction, partly by acting as a plug or cap. The slower the flow the more quickly does such a clot form. The cardiac weakness following on loss of large quantities of blood therefore favours cessation of bleeding.

In incised wounds, the divided ends of the vessel retract into the tissue, which then closes over them and checks hæmorrhage. The outer coat of torn and crushed vessels often becomes twisted into a kind of cord, while the intima is induplicated after the fashion of a valve. Bleeding is therefore often slight even when very large vessels have been torn or crushed. A clot having once formed extends, as a rule, up to the next collateral branch of the injured vessel.

The exact nature of the changes by which a divided vessel is closed is not yet clear, and although we know that a thrombus forms, yet the reason of its formation is still disputed.

Brücke has shown that the movement of the blood and the influence of the undamaged tunica intima are the two essential factors in preserving the fluidity of the blood, but authorities differ as to the exact mechanism by which thrombi are formed. It was formerly believed that the blood simply clotted, as happens under the influence of the fibrin ferment on the fibrinogen when blood is withdrawn from a vessel. Later investigations have shown, however, that the thrombus does not always consist of coagulated blood, and thrombi have been

divided into two classes—the red and the white. Zahn states that white thrombi result from accumulation of white blood-corpuscles in the lumen of the vessel; others, however, regard white thrombi as being formed by "blood-plaques," *i. e.* small, colourless, discoid elements, the origin and significance of which are still doubtful. These are said to adhere to the injured portion of the intima coat, and finally to entirely close the lumen of the vessel.

Red clots result from coagulation of the blood, but in the living body they occur much less frequently than the white, though they are seen after severe damage to the vessel wall implicating the intima; they are commonest in infectious diseases. Red clots are, therefore, most commonly seen in inflammatory diseases of the vessels and in pyæmia. Sometimes white and red clots may be formed simultaneously in the same vessel.

Ligation of an artery is not always followed by thrombus formation; should the tunica intima not be gravely damaged or infected, the endothelium proliferates and the walls become adherent. In other cases a white thrombus forms, or if the parts be severely injured or the circulation be gravely impeded a red thrombus may be produced.

Pathological clotting demands not only the presence of fibrinogen and fibrinoplastic substance but also of fibrin ferment, which is furnished by the injured cells. In this case the essential part is played by the endothelium of the vessel, which, owing to defective circulation, undergoes degenerative changes, and thus brings about clotting.

The thrombus either become converted into organised connective tissue or it softens and breaks down. The former is the more favourable development, and consists in the gradual replacement of the thrombus by connective tissue, which usually results from proliferation of the endothelial lining of the vessel. The endothelium is first converted into polymorphous "formative cells," which rapidly multiply, extend into the thrombus and replace it, leaving of the original thrombus only a pigment residue (oxyhydrate of iron). From the vasa vasorum new blood-vessels extend into the new tissue, converting it practically into connective tissue. The thrombus thus plays a passive part, being gradually replaced by fibrous connective tissue. These changes occur with comparative rapidity; vascular new tissue may be found at the point of ligation eight days after operation; in three to five weeks the thrombus, which, like a cicatrix, gradually contracts, is entirely organised. Where, however, the intima is extensively diseased, or where general constitutional disturbance exists, the changes proceed more slowly. Sometimes the new connective tissue becomes permeated with hollow spaces (Rokitansky's sinusiform degeneration), and the lumen of the vessel may thus be again partially restored. Finally, the thrombus may become calcified, so that it resembles a stone. To the occurrence of this change in venous thrombi is due the production of "phleboliths."

Circulation is usually restored by collateral circulation, the smaller vessels enlarging and conveying the blood by parallel paths. This change also is often very rapidly effected, as shown by Nothnagel's experiments on rabbits. Six days after ligation of an important vessel the muscular coats of the dilated collateral vessels were found to be

thickened. This result was formerly attributed to rise in blood-pressure, but was regarded by Nothnagel as due to more rapid movement of the blood in the vessels in question, and to the resulting increased nutritive supply.

Hæmostasis by a plug or thrombus is, however, only a provisional measure. Its purpose may be frustrated by suppuration occurring in the walls of the vessel and extending to the clot, which then breaks down; or increasing blood-pressure may drive out the plug, an accident most likely to occur where the vessel is injured close to a collateral branch. In such cases secondary bleeding follows. Final closure of the vessel is only brought about by organisation of the clot and the cicatrix in the tissues surrounding the vessel, and by the union of the walls of the vessel itself.

Hæmostatic agents are very numerous, but of very varying utility. Many have now been entirely discarded; they persisted from pre-antiseptic times, when ligation was only too frequently followed by suppuration with separation and discharge of the ligature. They may be divided into (1) thermic, (2) chemical, (3) mechanical.

Of thermic agents the most popular is cold; it is, however, only useful for checking bleeding from capillaries or comparatively insignificant vessels, and even then is uncertain. The result depends on reflex contraction of the walls of the vessel and surrounding tissues checking the flow of blood. When a strong stream of water is used contraction of the tissues is increased by the mechanical stimulus. Heat is usually applied by means of the cautery; the tissue, together with a portion of the escaping blood, is carbonised and forms a firmly adherent scab which closes the lumen of the vessel. This succeeds well in the case of small vessels, but is of comparatively little value in dealing with the larger. To check bleeding from already existing wounds the cautery should be of a bright red or almost white heat, because a firm scab is required, and one wishes to prevent the cautery adhering to the wound. When, however, it is used to make incisions the instrument should be red and should be moved slowly. Owing to its greater convenience, however, the galvano-cautery has almost entirely replaced the hot iron for removing growths. Although the resulting scab is sterile, and if very small may even undergo absorption, it is impossible to effect primary union between wound surfaces so treated. For this reason the cautery as a hæmostatic instrument has largely been discarded, though in castration it is still used to close the divided spermatic artery. It may be remarked in passing that bleeding from hollow organs like the uterus is often best controlled by hot

irrigations. In human surgery steam of boiling water has recently been used with good effect for checking uterine bleeding.

Most styptics combine rapidly with the blood, and form with it a clot which adheres to the wound and closes the injured vessel. Some act by causing contraction of the vessel and surrounding tissues. Among those formerly employed were oak bark powder, tannin, mineral acids and their salts, alum, nitrate of silver, acetic acid, creosote, carbolic acid, alcohol, oil of turpentine, etc. Perchloride of iron in the form of liq. ferri perchlor. diluted with three parts of water was often used to moisten tampons which were applied to the bleeding spot. Among the most useful are mixtures of alcohol and water and carbolic or sublimate solutions, but under any circumstances styptics are only of use in dealing with capillaries and small vessels. In human surgery, a light brown powder, consisting of the soft hairs from the stem of an East Indian tree fern (*Cibotium Cumminghii*), is used externally. To check bleeding resulting from internal injuries, extract of ergot (*Secale cornutum*) has also been used with success. More recently it has been largely replaced by extractum hydrastis Canadensis (golden seal). In operative wounds all powerful styptics prevent healing by first intention owing to their caustic effect on the wound surfaces.

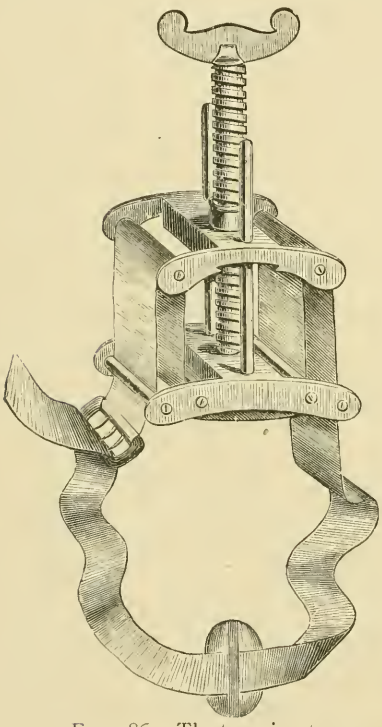


Fig. 186.—The tourniquet.

We may now consider mechanical methods of dealing with hæmorrhage. As a preventive, especially when operating on limbs, the application of a tourniquet (Fig. 186) or one or another form of Esmarch's bandage is the means usually employed.

In the horse the most primitive method consists in passing a loop of stout cord or webbing around the limb and tightening it by the rotation of a stout stick slipped through it. The pressure thus exercised on the vessels checks circulation, and hæmorrhage during operation is virtually *nil*, while owing to compression of the nerves sensation below the ligature is dulled and the pain of operation greatly diminished.

A more refined method is to use a rubber cord or tube. A rubber cord as thick as a man's forefinger and twenty to thirty inches in length is passed around the limb above the knee or hock in a stretched condition. The ends are united by a simple knot or a strong cord.

Esmarch's method is most valuable when, in amputating limbs in small animals or excising some very vascular organ like the uterus, one wishes to minimise bleeding. When properly carried out it enables operations to be performed as though on the dead body; no bleeding occurs, and all parts, the normal as well as the pathologically altered, are distinctly visible. Its inventor published a description of the system in 1873 under the title of 'Artificial Ischæmia.' It consists in applying an elastic bandage, formed preferably of vulcanised rubber (though a fabric of rubber threads covered with cotton is sometimes used), to the limb or organ to be removed, commencing always at the periphery. The strong pressure exercised by the spirals of the bandage as they advance over the tissues gradually drives the contained blood towards the trunk. When the parts to be excised have thus been rendered bloodless a thick rubber cord is applied with considerable pressure immediately above the bandage. This compresses the arteries and practically brings circulation to a standstill. The ends of the cord are secured by tying or preferably as shown in Fig. 187. The cord is stretched and slipped into the first of the incomplete cylinders; is then carried once or twice around the limb, stretched tightly to allow it to be inserted in the second cylinder, and then sharply released. Its elasticity causes it to swell up and to be firmly held in position within the cylinder. The bandage is then removed and the operation performed below the cord.

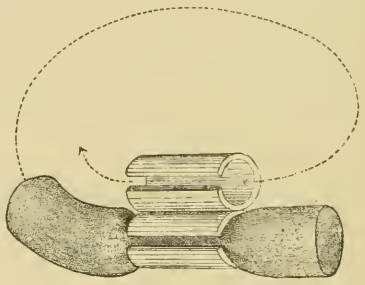


Fig. 187.—Catch for rubber cord used with Esmarch's bandage.

In this method two systems are associated, the blood being first expelled from the parts and the bloodless condition afterwards maintained by the tourniquet-like action of the rubber cord. When the part to be enveloped in the bandage is the seat of a wound of any notable extent the latter can first be covered with a layer of wadding or with a compress. The operation terminated and the vessels ligated the cord is cautiously loosened. It not infrequently happens, if the surface has not been cauterised, that abundant hæmorrhage follows from the numerous small arterioles and capillaries, due in large measure to vaso-motor paralysis, the effect of prolonged compression.

This can be checked by the cautery, by cold irrigations, the use of carbolic lotion, or by a compress dressing.

In veterinary practice Esmarch's method is not usually applied in its entirety, the operator often being satisfied with the application of the cord. Speaking generally, this is the best method of operating when the tissues have undergone much change, and are infiltrated with pus or infectious fluids which might be pressed back into sound tissue by the bandage and produce very grave results. The hæmorrhage, which, in consequence of venous stasis, is sometimes considerable, may be checked by applying a second elastic tourniquet on the opposite side of the region of operation.

The methods just described are only applicable to certain regions, so that when operating elsewhere other methods of dividing tissues are sometimes resorted to, such as crushing with the écraseur, blunt dissection, tearing, and the use of the elastic ligature. We have already alluded to the use of the cautery, galvano-cautery, and caustics. The écraseur (Figs. 111 to 113), though almost discarded by human surgeons, is still much used in veterinary practice. It crushes soft tissues, though to some extent it also acts like a saw. Mucous mem-

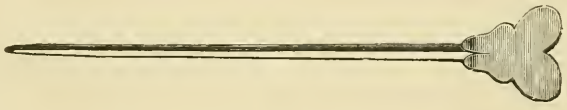


Fig. 188.—Director.

branes, connective and fibrous tissues, muscles, vessels, neoplasms, are all cut without hæmorrhage if the instrument is worked sufficiently slowly. Its action is especially remarkable in vessels: the middle and internal coats rupture and retract whilst the external coat is stretched and twisted in such a way as to effect almost complete closure. The secret of avoiding hæmorrhage is to work the instrument slowly. Pain, which is very severe as compression begins, diminishes with commencing section. As a rule the surface of section cicatrises less rapidly than that made by the knife, owing to superficial cell necrosis.

Tearing is chiefly used in removing sharply defined tumours which are only slightly adherent to neighbouring tissues. The skin having been incised the growth is isolated by pushing aside or tearing through the surrounding tissues with the fingers, or by a combination of these methods. Although valuable on account of not endangering important vessels or nervous trunks, this method gives very acute pain where the parts are richly supplied with nerves, and is inapplicable to such new

growths as spread by the lymphatics, inasmuch as extirpation is incomplete and secondary tumours soon grow.

For blunt dissection the end of a director or a small spatula may be used. The movement is of a stabbing or thrusting character, the point tearing through the connective tissue and isolating the part

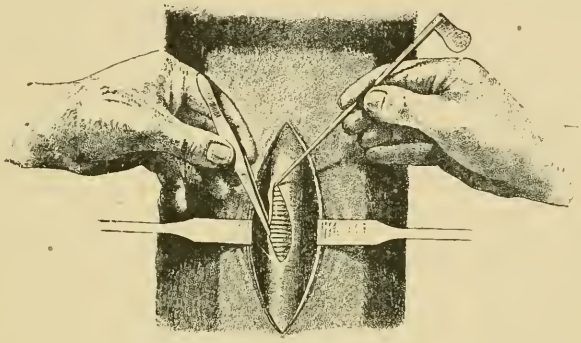


Fig. 189.—Ligating an artery; first stage.

without danger of hæmorrhage. This method is excellent when operating in dangerous regions. It is particularly useful for isolating vessels, as in ligaturing the jugular vein or carotid artery, and in neurectomy. The wounds produced by blunt dissection heal almost as quickly as those made with the knife. Different methods of ligation are often employed to cause sloughing of tumours, organs or portions of organs, like the vagina and uterus, and thus ensure bloodless removal. The most generally useful is the elastic ligature.

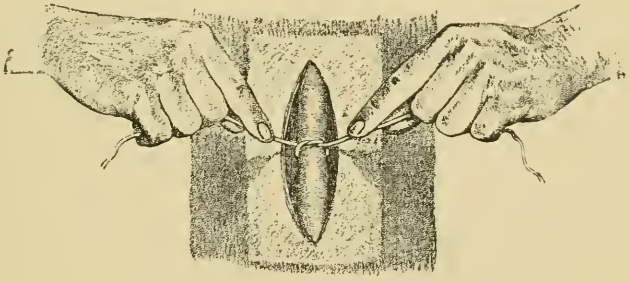


Fig. 190.—Ligating an artery; second stage.

When arterioles, small veins, or vessels of larger size are divided, bleeding can only be checked by compression, packing the wound, cauterisation (already noticed), ligation, torsion, or forcipressure.

Compression is useful where one cannot stop to ligate the divided vessel. The portion of the wound where the divided vessel is seated is

compressed either with the finger or with a tampon of cotton wool (immediate compression). In the event of this failing, the main vessel supplying the parts is compressed at the point nearest the wound, where it can be brought directly against a bone (mediate compression). This plan rarely stops bleeding completely, however, and at the end of the operation one is obliged to resort to some other method. In dealing with hollow wounds long strips of antiseptic gauze, tarlatan, or muslin may be packed into the cavity under pressure, and the lips of the wound provisionally united by a few sutures. This usually checks bleeding from small vessels.

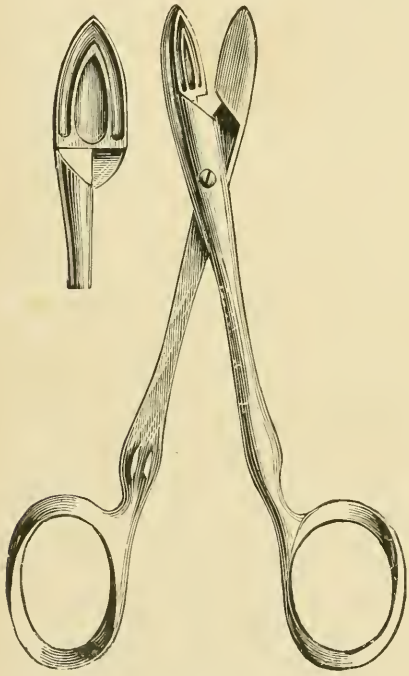


FIG. 191.—Greig-Smith's artery forceps.

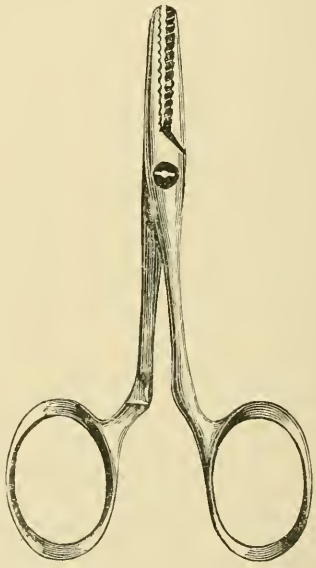
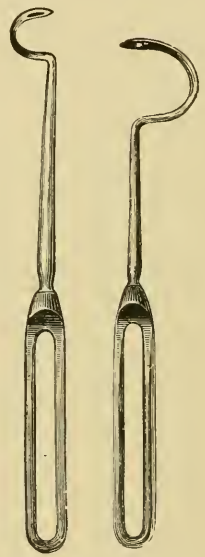


FIG. 192.—Spencer Wells' artery forceps (with separable limbs for cleaning).

Ligation is effected with threads of silk or catgut; chromic gut is the best. When an artery crosses the field of operation, and must be divided, it is isolated, ligatured in two places, and the section made between the two ligatures. If a vessel, whether artery or vein, is accidentally divided, the ends are grasped with forceps or a tenaculum and strongly ligatured as high up as possible, using a surgical knot. In the case of an artery, the object is to divide the inner and middle coats, which retract, and become incurved towards the axis of the vessel, whilst the external stretches slightly,

and its surfaces are brought into close apposition one with another. When using catgut the ends of the knot may be cut short, but in the case of silk only one is cut short, the other being brought outside the wound unless asepsis be assured. It is withdrawn a day or two later, when the vessel has been cut through. Wells or Greig-Smith's forceps, with large jaws of conical or cylindro-conical section, are very convenient when ligating vessels. The ligature, on being tightened, slips over the nose of the forceps, and surrounds the vessel. Immediate ligation is always to be preferred. Where it is impracticable, as when the ends of the vessels have retracted deeply within the tissues and cannot be discovered, or when the tissues are very friable and break away as grasped, mediate ligation, or ligation in the continuity of the vessel, may be performed.

Fig. 193. Fig. 194.



Figs. 193, 194.—Aneurysm needles.

The instruments required are a scalpel, two retractors, dissecting forceps, a director, ligatures, and aneurysm needle (Figs. 193 and 194), *i. e.* a curved needle with fixed handle. The method is as follows :—The skin is incised directly over the artery, the lips of the wound are drawn apart with retractors, and dissection cautiously continued until the artery appears. A fold of the artery sheath is then lifted and divided, leaving the artery itself free. If preferred the artery sheath may be torn through, using two pairs of dissecting forceps. The artery is freed from its sheath for some distance (Fig. 189), which is semi-schematic. One margin of the sheath is lifted with forceps and drawn slightly away from the artery, around which the ligature is passed by means of an aneurysm needle. Care must be taken that only the artery, and not the accompanying vein or nerve, is included in the ligature. One end of the ligature is held fast with the fingers or forceps and the needle drawn back, leaving the thread around the vessel. The knot is tied in the manner before indicated, and shown in the semi-schematic illustration, Fig. 190. The ends of the ligature are then cut off short, and the wound sutured and dressed. After ligation the neighbouring parts are nourished by collateral anastomosing branches (Fig. 195). In injuries of large vessels, however, the existence of this collateral circulation is sometimes responsible for secondary bleeding from the peripheral ends should the vessel not have been ligatured both in front of and behind the injured spot. In former times it was considered dangerous to ligature veins. Nowadays no

distinction is made between veins and arteries. Large veins, however, should be doubly ligatured for similar reasons to those above stated, and also because in the case of large veins air might possibly be aspirated through that portion of the vein nearest the heart with fatal consequences.

Torsion may replace ligation in dealing with small arteries and veins. The mouth of the bleeding vessel is seized with forceps, drawn slightly forward, and the forceps rotated on their axis. To make quite sure of obliterating the vessel some surgeons continue torsion until the coats rupture (unlimited torsion). As in ligation, the middle and internal coats are ruptured, and become induplicated; the external coat being stretched and twisted forms a kind of cap, which covers the clot, and gives it much greater firmness. Ligation, however, is always more certain than torsion. In arterioles of considerable size, moreover, the fibrous coat may untwist, giving rise to secondary hæmorrhage.

Fig. 195.—Figure showing restoration of blood-supply by collateral vessels after ligation of main trunk; from a preparation of the femoral artery of a large dog eight months after ligation.

Forcipressure by means of artery forceps has largely replaced other means of checking bleeding. It consists in applying to the mouths of divided vessels special forceps (Wells' form is the best), which are left in position for a varying time, sometimes until the vessels are blocked by clot, sometimes only until ligatures can be applied. If during operation a small artery is divided forceps are immediately applied. By using a number incisions may be made through very vascular tissues with little interruption or loss of blood. To keep the operative field clear they are held to one side by an assistant. It is not necessary that all should be left in position until the end of the operation; arteries of very small dimensions, if compressed for a few minutes, no longer bleed when the forceps are removed. Should a large vessel be divided, it can be grasped and closed with Wells'

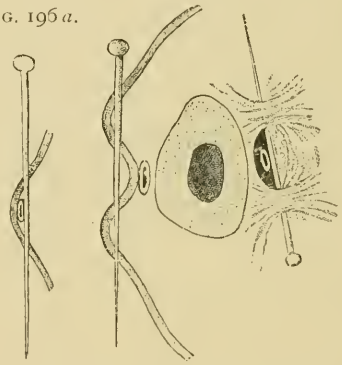
forceps, and immediately ligatured; this prevents the seat of operation being obscured with blood.

In human surgery, when dealing with deeply situated vessels, which it would be difficult to isolate and ligature, the forceps are sometimes left in the wound until the blood-vessel has become entirely filled with clot. In such case they are fixed between the layers of the dressing or between the lips of the wound, and removed at the end of twenty-four to forty-eight hours, according to the size of the vessel to which they have been applied. Needless to say, forceps, threads, and instruments must all be aseptic, an indispensable condition if one wishes to effect primary union or prevent accidental infection.

Acupressure never found much favour in veterinary practice as compared with human surgery, because animals are too difficult to control. At the present day it has lost much of its value, inasmuch as materials for ligaturing vessels are available which can be left permanently in position without danger. Acupressure is effected by thrusting a pin vertically into the soft tissues about three eighths to three fourths of an inch from the artery, carrying it in a horizontal direction over or under the artery, and causing it to emerge a similar distance on the opposite side of the vessel. The opening of the artery is thus pressed either against soft parts, or, better still, against a bone (see Figs. 196 *a* and 196 *b*). When this is ineffective or impossible to carry out, two needles are employed, one passed below, the other above the vessel.

Fig. 196 *b*.

Fig. 196 *a*.



Figs. 196 *a*, 196 *b*.—Method of practising acupressure.

The elastic ligature is an excellent means of stopping bleeding. Applied with tension to a certain thickness of living tissue the rubber loop continues to diminish in diameter, and to cut until it becomes entirely relaxed. This constitutes a great advantage over the simple ligature, the action of which, though at first severe, rapidly diminishes and soon comes to a standstill, necessitating a new ligature being applied, or the old one tightened soon after the superficial layers of tissue have been divided. The elastic loop has no action on inert bodies, even though comparatively soft, or on dead tissues, but rapidly divides all living tissues like skin, muscle, vessels, tendons, or even bone. Nothing living can resist it. Division proceeds without hæmorrhage,

the walls of vessels becoming adherent before yielding and the lumen being blocked by a thrombus. Cicatrisation is rapid, and the wound is relatively small.

The applications of the elastic ligature are numerous, the method of application simple. Vulcanised rubber tubing or cord, of a thickness proportionate to the mass to be divided, is used. An assistant holds one end of the cord while the operator grasps and stretches the other, passing it three or four times around the pedicle of the growth. The two ends are held in a crossed position by an assistant, when they can be tied together with an ordinary thread.

In removing tumours with well-defined pedicles the elastic band is easily applied, but when the tumour is more or less sessile it is necessary to transfix it with one or two long needles crossed at right angles to prevent the ligature slipping off.

Since Rossignol and Cagny's experiments the castration of lambs by the elastic ligature has become very common in France. Rossignol had only three cases of tetanus after castrating two thousand two to three months old lambs during very hot weather. It is equally useful for bovines. In Egypt, Siot operated on nearly two thousand bulls or buffaloes during 1885 without accident or complication of any kind. The method was as follows:—The scrotal region and ligature were disinfected; during the next few days the parts were moistened with an antiseptic; on the sixth to the eighth day the gangrenous parts were cut away, and the stump smeared with a little recently boiled tar. Generally the animals returned to work on the fifteenth to the twentieth day.

The elastic ligature has been tried in the castration of solipeds, but grave complications like tetanus, septicæmia, and peritonitis have caused the method to be abandoned. Its applications, however, are many. When the prolapsed uterus cannot be reduced, or is the seat of grave change, a strong elastic ligature may be applied at the base, the parts amputated an inch or two beyond, and the stump disinfected and returned. Loss of blood may be prevented by applying an Esmarch bandage before operation. Cagny has recommended the elastic ligature for docking. The most painful part of this operation is not the division of the tissues, but their cauterisation, and in certain high-bred animals the application of the iron causes violent struggling. Cauterisation can be dispensed with by applying before section an elastic bandage to the tail just above the point of division. It has been suggested that the bandage should be left in position for a week, but this would be dangerous, and it is sufficient to leave it twenty-four to forty-eight hours.

CHAPTER XII.

THE INJECTION OF MEDICINES INTO THE BLOOD-STREAM, SUBCUTANEOUS TISSUE, TRACHEA, ŒSOPHAGUS, LARYNX, OR PARENCHYMA OF ORGANS OR TISSUES.

1. Intravenous injection. In former times bleeding was often a preliminary to intravenous injection of medicines. In horses, for instance, the jugular vein was opened with the fleam, and the medicine injected by means of a funnel and tube. Apart from the danger of thus introducing air into the vein phlebitis often followed. At the present time syringes with hollow needles are alone used for intravenous injection. They are preferably of considerable size, holding up to 1½ fluid ounces, or better still, are double-acting, drawing in the injection fluid on the up stroke and passing it into the vein on the down stroke. This arrangement avoids the necessity for continually removing the needle, and so minimises injury to the intima of the vessel, a fruitful cause of thrombosis and phlebitis. The injection may also be made by means of a funnel and rubber tube connected with the hollow needle.

Only certain materials are suitable for intravenous injection; they must, for instance, at least conform to the following requirements:— They must be fluid, *i. e.* form perfect solutions without sediment; for this reason the fluid should be carefully filtered before injection. They must be miscible with the blood. Oils, etc., therefore, may not be used, as they might produce thrombi. They must not undergo any marked decomposition which might lead to clotting of the blood; so that acids, concentrated alcohol, etc., must be avoided. They must be fairly active, as the injection of large quantities of fluid into the blood-stream might prove disastrous. An exception exists in the case of normal salt solution (·6 per cent. sodium chloride solution) when injected

to prevent collapse after hæmorrhage. Lastly, they must be approximately of the normal body temperature, and as far as possible sterile.

In consequence, the number of materials fitted for intravenous injection is limited to a few alkaloids, etc., and since the introduction of hypodermic medication even these are less and less frequently given by the veins. The intravenous method has the advantage of producing its immediate effects, while subcutaneous injections require at least four or five minutes, but this advantage is more than offset by the time required to prepare the solutions and the seat of operation previous to intravenous injection. Materials, however, like chloral hydrate, veratrin, etc., which prove locally irritant, and which therefore cannot be given subcutaneously, may be administered by the veins.

Injection with the ordinary syringe is carried out as follows :— After preparing the solution and carefully bringing it to blood-heat, the operator grasps the shaft of the hollow needle between the index and middle fingers of the right hand, the thumb resting on the broad expanded base. The right jugular vein is compressed with the thumb of the left hand and the needle thrust obliquely downwards through the skin covering the most prominent part of the swollen vein at the spot usually chosen for bleeding. As the animal is often restless at this stage the right hand is simply pressed against the neck without for the moment attempting to introduce the needle further. As soon as it becomes quiet the needle is sharply thrust a little further in the same direction. If the attempt has been successful blood will flow from the open end of the needle when the thumb is removed, showing that it has entered the vessel; otherwise another trial must be made. The needle is introduced as close as possible to the point compressed by the thumb, as the vein is partially fixed there and is less likely to evade the needle. Once introduced into the vein the needle should be moved as little as possible to prevent injuring the intima. Having satisfied himself that the syringe contains no air, the operator then affixes it to the needle and steadily injects the contained fluid into the vein.

The double-acting syringe is employed in a similar way. One nozzle is connected by a rubber tube with the needle inserted in the vein, the other by a similar tube with the vessel containing the injection fluid. After injecting the contents of the syringe into the vein the two-way tap is turned and the barrel of the syringe again filled by drawing back the piston. By returning the tap to its original position and once more pressing down the piston a second quantity is injected; the process can be repeated as often as desired. The method is very convenient, but as it necessitates the application of a sideline or of

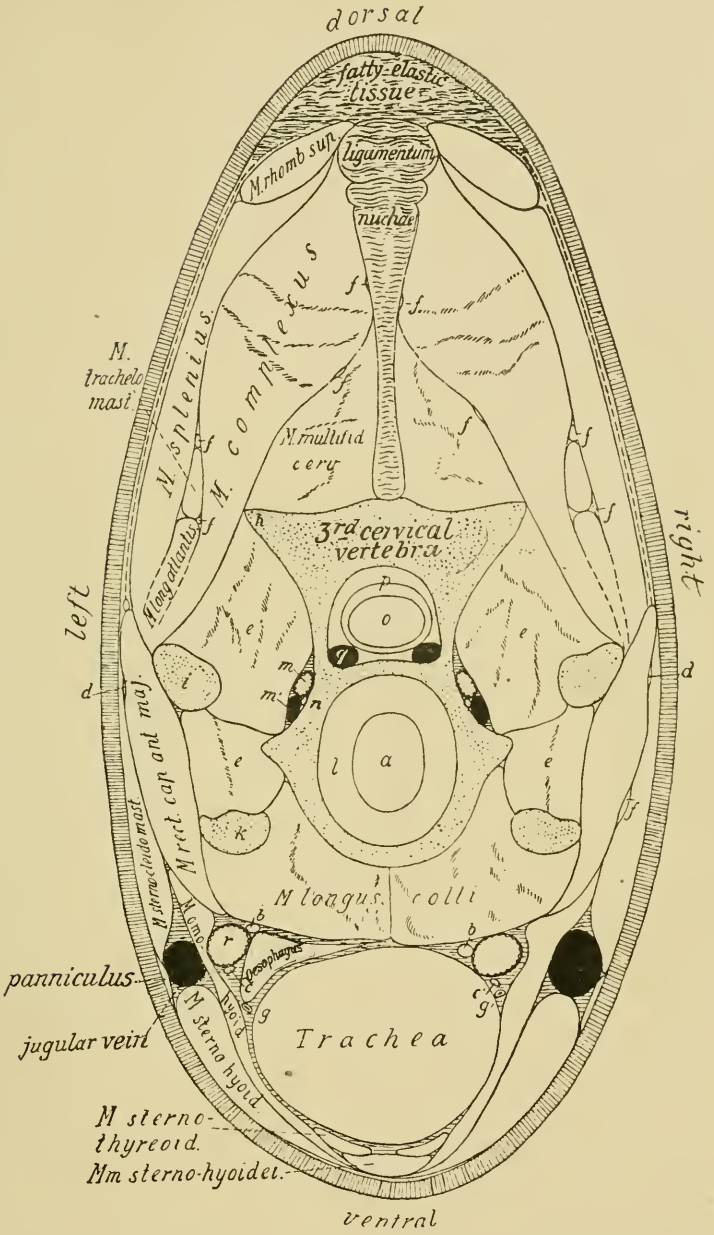


FIG. 197.—Transverse section of the neck at right angles to its long diameter. The section passes through the third cervical vertebra. *a*, Portion of the head of the fourth cervical vertebra; *b b*, Vagus and sympathetic nerves; *c c*, Recurrent nerves; *d d*, Dorsal branches of spinal accessory nerve; *e e*, Intertransversales colli muscles; *f*, Muscular twigs of the cervical nerves; *g g*, Tracheal lymph duct; *i*, *k*, Transverse processes of cervical vertebra; *l*, Intervertebral disc of cartilage; *m m*, Vertebral artery and vein; *n*, Lymphatic nerve twig; *o*, Spinal cord; *p*, Membranes of the cord; *q*, Vessels of the cord; *r*, Carotid artery. (After Ellenberger and Baum.)

hobbles it is usually replaced by the use of a glass funnel and rubber tube, which has the additional advantage of being very much cheaper than the syringe.

In this case the needle is introduced as before and the funnel attached to the end of the rubber tube which should be filled with, say, warm normal salt solution, so that all air is excluded, and should be closed with a pinch-cock for controlling the flow.

One of the drawbacks of intravenous injection is the tendency to thrombosis of the vein in consequence of injury to the tunica intima by the needle. This danger, however, as well as that of the entrance of air, can be avoided by skilful manipulation. By proper care in choosing the drug and carrying out the above manipulation bad results are avoided.

Fig. 198.—Double-acting syringe.

2. In subcutaneous or hypodermic injection, which has largely replaced the above method, the drug is injected by means of a syringe and hollow needle into the loose connective tissue beneath the skin. A graduated syringe holding about 2 to 4 fluid drachms is used and the injection made at a spot clear of the harness and where the skin is freely movable, *i. e.* where subcutaneous tissue is abundant. The side of the neck, breast, behind the elbow, and flank are convenient positions.

Hypodermic solutions should as far as possible be sterile and unirritating. The various alkaloids are most useful. The syringe and needle should be thoroughly clean and preferably sterilised by boiling or by thoroughly washing out with 5 per cent. carbolic or creolin solution. This precaution is doubly necessary when the syringe has been previously used for animals suffering from contagious disease. Some operators also disinfect the seat of injection, though this precaution is perhaps scarcely necessary.

Raising a fold of skin with the thumb and index finger of the left hand the operator passes the needle either along the fold or at right angles to it into the subcutaneous tissue. It occasionally happens that a blood-vessel is penetrated, as shown by the escape of a few drops of blood, and, under these circumstances, it might be dangerous to inject insoluble substances like veratrin. In such case the needle is slightly withdrawn, and if the bleeding ceases the syringe may then be fitted to

the needle, the fluid slowly injected, and the needle withdrawn; by softly stroking the skin, the injection is dispersed over a larger area in order to promote rapid absorption.

3. Intratracheal injection is practised for the purpose of treating disease of the upper air-passages like chronic laryngeal or tracheal catarrh, to kill parasites present in the trachea and bronchi, and as a means of combating certain general disorders like purpura hæmorrhagica and hæmoglobinuria. As absorption occurs very rapidly from the tracheal and bronchial mucous membrane this system of medication has a rational basis, but, as a rule, more convenient and less dangerous methods deserve preference. From the experiments made it has become clear that the tracheal mucous membrane is far less sensitive than was formerly imagined, and that irritants like tinctures and oil of turpentine are really very well borne. As, however, the tracheal mucous membrane cannot be disinfected the small punctured wound does not heal aseptically, and although in healthy animals little need be feared, yet, should inflammatory action set in, as may readily occur in purpura, serious consequences may follow; recent experience shows that gangrene of the tracheal mucous membrane and even of the lungs sometimes occurs. The needle must be cautiously inserted, and as it is sometimes subject to considerable stress during the animal's struggles it should be stout in order to avoid breakage. In the event of this occurring the broken fragment must at once be grasped with forceps, or, if it be invisible, a cutaneous incision must be made in order to detect and remove it.

Intratracheal injections may be made with a specially large ordinary syringe provided with stout needles, with a large Pravaz syringe, or with Dieckerhoff's syringe, which is used in conjunction with a special trocar and cannula. The animal's head is raised, and the operator, stretching the skin covering the front of the trachea with the fingers of the left hand, thrusts the needle or trocar through the space between two tracheal rings. Removing the stilette he inserts the nozzle of the ready-filled syringe in the mouth of the cannula and slowly injects the contents into the trachea. In horses, from 7 to 8 fluid drachms may thus be administered.

Dieckerhoff also recommends intralaryngeal and intrapharyngeal injections. The method is similar to that above described. A curved needle, with its concavity directed upwards, is passed between the cricoid cartilage and the first ring of the trachea, traversing the cricotracheal ligament, and fluid is thus injected into the larynx or pharynx. In chronic laryngitis Dieckerhoff recommends subnitrate of bismuth or 1 per cent. iodine solution (Lugol's solution) repeated every few days.

4. Parenchymatous injection consists in introducing solutions of drugs into the parenchyma of organs, like the thyroid or lymphatic glands, or into muscles or pathological new growths. The active agents are thus brought into immediate contact with the affected tissues. In veterinary surgery actinomycotic growths are the commonest objects of such treatment, though tumours and the swellings of goitre have also been injected, but with varying results.

Solutions of acetic, carbolic, or lactic acids, iodine, zinc chloride, papain, etc., have all been used for parenchymatous injection. In the hands of several operators iodine and papain have given good results when employed against soft new growths and goitre.

A rather stout needle is inserted—if possible, into the centre of the organ or growth (sometimes a specially long needle is required), and the solution injected. A few drops are often sufficient. Slight pressure should be kept on the piston during withdrawal. Sometimes several injections are made at different points. The operator judges of the need for repeating the operation by the condition of the diseased parts, and by the reaction which follows. As a rule one should wait until all signs of the previous treatment have disappeared.

The principle of parenchymatous injection is not new, for a somewhat similar process, *viz.* the introduction of solid caustics like arsenic and sublimate, has been in use since very early times.

CHAPTER XIII.

BANDAGING AND DRESSING.

Since the introduction of antiseptic wound treatment dressings play a much more important part than formerly, when open wound treatment was the usual custom. They not only shield the wound from infection and absorb wound secretions but favour healing by primary intention, and retain soft parts in contact very much as callus formation fixes the broken ends of bones. Dressings are also useful to retain given parts in predetermined positions and to exercise pressure. Unfortunately, in veterinary surgical treatment, dressings cannot always be made secure owing to the animal's restlessness and the mobility of its skin, while the dangerous results which may follow displacement of or pressure by dressings are often so considerable as to deter practitioners from their use altogether.

The best materials for dressings are gauze or muslin, jute, and absorbent cotton wool, supplemented when necessary by the use of the cheaper wood wool, prepared peat, oakum, etc. Uncleansed tow, which was formerly much used in veterinary surgery, should be absolutely discarded except as a padding for splints, etc. The special merits of each material will be considered later. Compresses may be of linen, cotton, flannel, etc. To cause them to fit properly without creasing they must often be slit at the edges. Dressings and compresses are secured in position in various ways, the commonest being by the use of bandages. These were formerly of linen or flannel, but for surgical purposes nothing surpasses calico, tarlatan, or cotton bandages which can either be cut of suitable size and length from a large piece of stuff or, better still, bought ready for application from the surgical apparatus dealers. In addition to cheapness they have the advantage

of adapting themselves readily to irregularities of surface and of being very absorbent. Flannel bandages stretch irregularly in use, and as they soon lose their elasticity finally become wrinkled. Knitted bandages are very elastic and even after long use may by proper treatment be rendered almost as effective as when new.

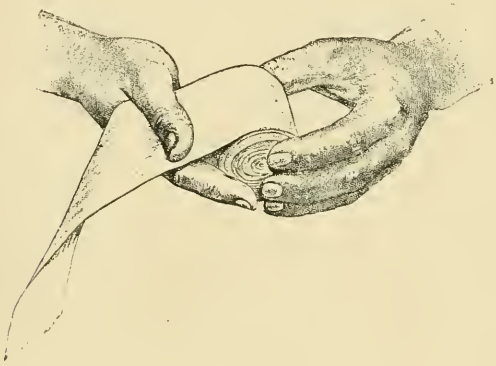


FIG. 199.

Bandages intended for fixing parts immovably in position may be saturated with dextrin and dried. They can also be bought ready prepared, requiring only to be thoroughly moistened before use, when the turns adhere strongly, forming practically one mass. To promote absorption of extravasated fluids elastic bandages are very useful. Some are made of elastic thread covered with cotton or silk, others of pure rubber: the latter, on account of their durability and the ease with which they can be cleansed, are to be preferred in spite of their higher price. By intelligent application excellent results may be obtained with these bandages, though careless use of them may also do great harm. The most important point is to apply them with equal pressure throughout. A very good plan is for the operator first to test the effect of the bandage on his own person, for example on the arm. Even with apparently slight pressure he will soon find it unbearable. As such elastic bandages cannot safely be placed in unskilled hands, and as continued pressure is often desirable, elastic stockings or gaiters can be used. They may be safely applied by any groom provided they fit properly in the first instance.

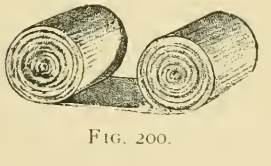


FIG. 200.

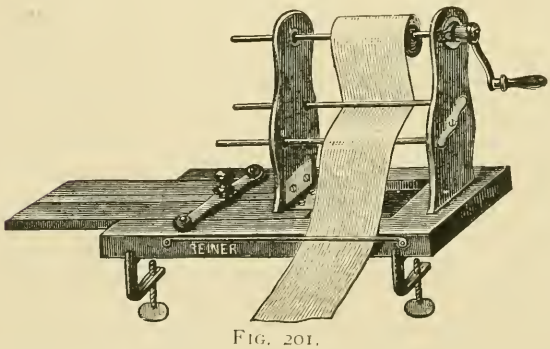


FIG. 201.

As a rule bandages should not exceed 2½ to 4 inches in width

except such as have to be applied to the horse's body. The more slender the part to be bandaged the narrower must be the bandage, it being particularly difficult to apply broad bandages without producing creases, especially in the neighbourhood of joints. Before application the bandage must be rolled; one end is first folded several times on itself forming a small cylinder which serves as an axis for further rolling; the best method is shown in Fig. 199.

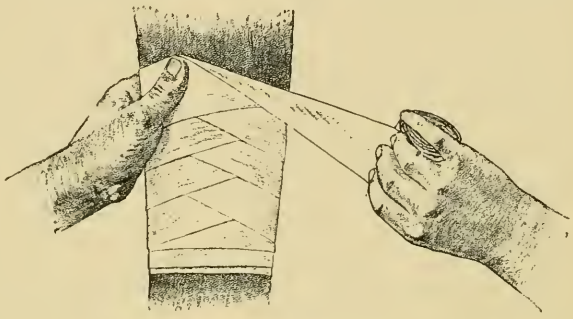


Fig. 202.

Bandages may be either single, double, or many tailed. The single ended bandage, forming a single roll, is that most in use. The double ended (Fig. 200) is rolled from both ends towards the centre, as is the multiple bandage, which, however, is now seldom seen. A very useful apparatus for rolling bandages is that shown in Fig. 201.

Bandages should always be applied from the periphery towards the centre, never in the opposite direction, which would lead to congestion of the veins and lymph vessels. This precaution is often overlooked, the operator commencing in the middle of a limb. The simple experiment of applying a bandage to the middle of the forearm will soon convince anyone of the undesirability of this course; the veins of the hands become enormously swollen. In hoofed animals we cannot commence at the extreme periphery, but the bandage should certainly begin about the cornet and not, as is so commonly the custom, above the fetlock-joint. Simple circular turns, by which the bandage is applied to one spot alone, are now seldom employed for the reasons previously given, but they form the commencement and end of other methods. In spiral bandaging the upper edge of each turn is covered by the lower portion of the next in order; as each succeeding turn is

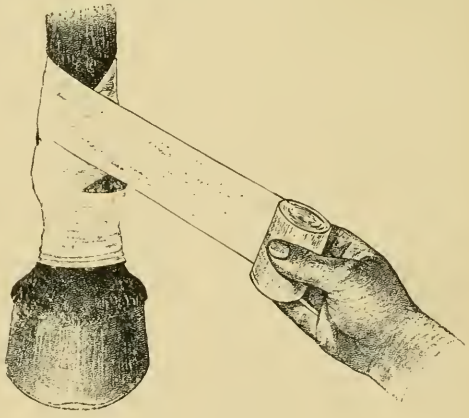


Fig. 203.

applied it is temporarily fixed in position by the index finger or thumb of the left hand until the next turn overlaps and fixes it in position. The first circular turn should be double to give greater security; those following take a gradual upward spiral course. On regions of conical section like the forearm, or such as are not truly cylindrical, spiral bandaging can only be successfully carried out by using very elastic cotton bandages, otherwise the lower edges of the bandage always project. This, however, can be avoided by reversing the bandage at each turn as shown in Fig. 202, the upper and lower edges changing places. The bandage, held in the hollow of the right hand, is drawn tight, rotated, and the folded point fixed with the thumb or index finger of the left hand. The bandage is then rapidly passed round the limb, and again drawn tight, the thumb of the free hand keeping the fold flat meanwhile. These precautions, however, are scarcely necessary when using knitted, elastic, or calico bandages, especially where the latter are moist. To maintain pressure on a joint like the fetlock the figure-of-8 shown in Fig. 203 is useful. The bandage is passed once or twice around the pastern, thence obliquely upwards over the anterior surface of the fetlock, behind the joint and then forwards and downwards in a direction opposite to that of the previous turn. The position of each succeeding figure-of-8 should be slightly varied so that the entire surface of the joint is covered. To secure the degree of tension required to keep the bandage in place without causing undue pressure at any point requires some practice. Until this knowledge is acquired it is better to err on the side of slackness.

When moist applications are needed it is often best to soak the bandage before use, otherwise it contracts when wetted and may cause greater pressure on the diseased part than is intended. For the same reason moist bandages, which will afterwards be allowed to dry in position, may be drawn rather tighter than if they had been applied dry, the pressure diminishing as the moisture evaporates. It is not possible to fix dressings in all positions with bandages. In many cases considerable ingenuity is required to secure the desired fit, and the following illustrations (redrawn from Bourgelat) are intended to assist operators in this task. In the illustrations (Fig. 204 *et seq.*) indications are given of where a fold or a gusset is needed and where a portion of the cloth is to be reinforced with lining. In many places, however, even these applications do not meet all the requirements of antiseptic wound treatment. Thus after removal of the large growths which occasionally form in the shoulder region in consequence of collar pressure Bayer prefers the following device:—He first inserts sutures of relaxation, using drainage-tubes of large size. The sutures

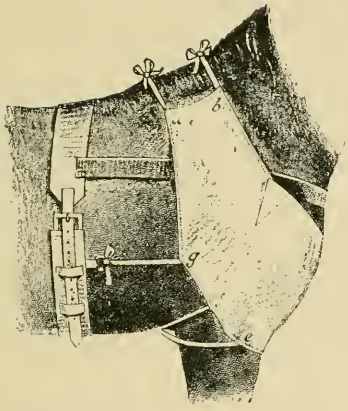


FIG. 204.

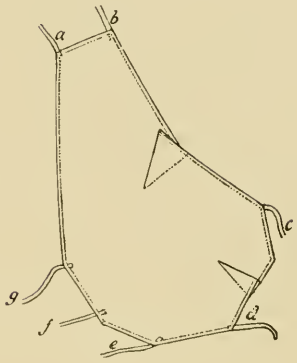


FIG. 205.

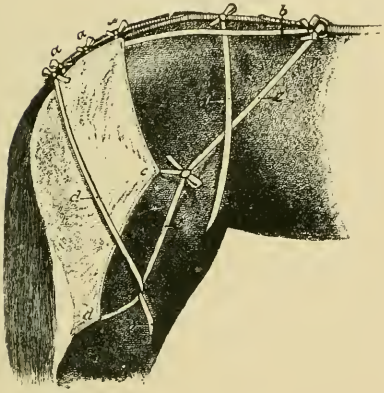


FIG. 206.

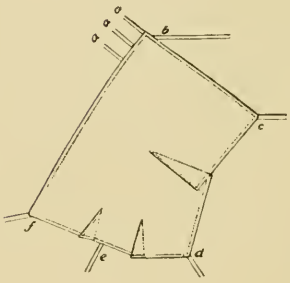


FIG. 207.

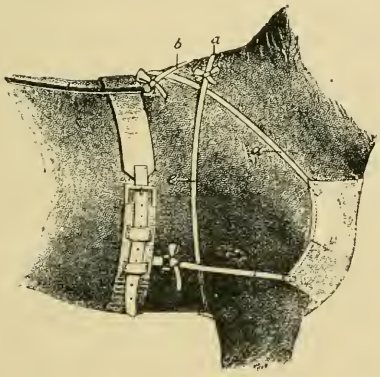


FIG. 208.

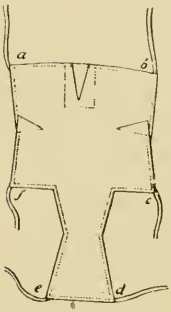


FIG. 209.

are passed at a distance of 1½ inches from the margin of the wound and comparatively deeply; the number inserted naturally depends on the size of the wound. A drainage-tube is then inserted and the wound closed with closely placed interrupted sutures. Bayer insists on the importance of drawing up a fold of skin, thus producing a ridge ½ inch high before inserting these sutures. A large piece of iodoform gauze is spread over the whole field of operation and fixed to the rubber tubes used for securing the sutures of relaxation. The gauze covers the drainage-tube. The horse is then allowed to rise and the space marginated by the rubber tubes is protected with a pad of dressing material which is caused to press on the wound by thrusting broad strips of thin elastic wood, similar to that used in the manufacture of hat boxes, under the rubber tube on either side. This brings the surfaces of the wound together and facilitates union. The trifling local prominences caused by the stitches do not prevent the application of a well-fitting collar and usually disappear in a month or two, leaving a scarcely visible linear scar.

The dressings used in *fractures of bones* may be divided into two kinds, viz. those of a temporary character—termed provisional—and those intended to be more lasting—permanent dressings. The choice for the first dressing is often very restricted, and whatever first comes to hand may require to be used. In this case broad strips of linen or even of sacking are sometimes first applied as a padding and support, and the splints, formed of flat pieces of wood, are applied on either side of the long axis of the bone and fixed in position by cords or straps. Pieces of wood may be replaced by bundles of straw. The broken part being thus protected the horse should be removed as rapidly as possible to the stable, and the permanent dressing applied. If time permit the supporting pieces of wood may be sewn between linen pads. To increase the firmness of the dressing rolls of straw, lengths of sole leather, straw board or bark or pieces of lead moulded to the shape of the part, can be employed in place of wooden splints.

Permanent dressings are prepared with starch, dextrin, plaster, tripolith, glue, gutta-percha, plastic cardboard, and poroplastic felt. When applying any of these care must be taken that the broken parts are first replaced as nearly as possible in their natural positions, and so retained until the dressing has become quite hard. The dressing must not press unduly on any point as this would cause sloughing of the skin, a complication specially liable to occur where prominent bony processes have to be included in the dressing. The portions to be covered and their immediate neighbourhood are therefore first supported by the application of a sheet of linen, over which wadding

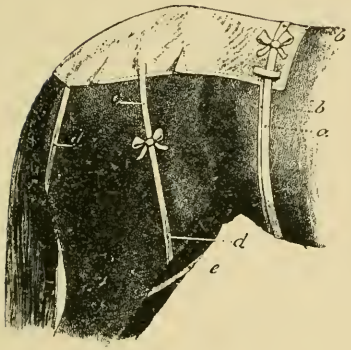


FIG 210.

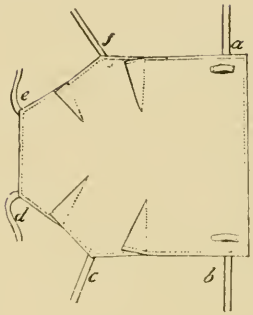


FIG. 211

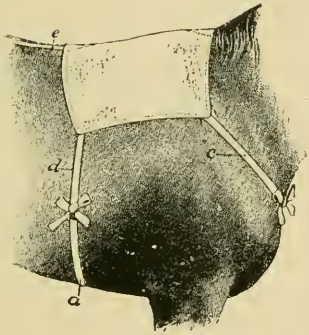


FIG. 212.

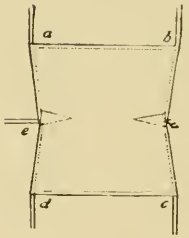


FIG. 213.

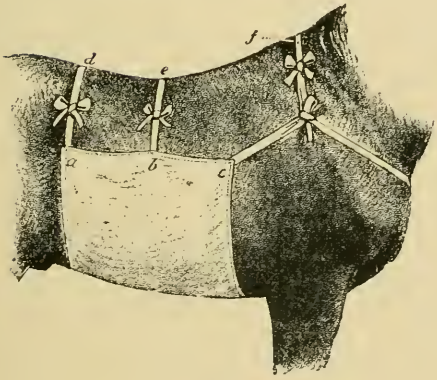


FIG. 214.

FIG. 215.

or some soft material is thickly applied and is retained in position with a soft bandage. Instead of wadding, soft flannel bandages can be employed; these perhaps fit better and are preferable. After thus filling up all irregularities of contour and bringing the dressing to a level surface, the permanent bandage, impregnated with some hardening material, is applied.

A common error is to apply the dressing to the fractured point alone. It is, however, absolutely necessary to extend it upwards beyond the next joint and downwards as far as the hoof or claw. Any weight thrown on the limb is thus transferred to the bandage, which acts somewhat like a cylindrical crutch, the broken bone being relieved of pressure and preserved from any movement likely to prevent union.

In applying *starch bandages* the parts are padded as described, and cardboard splints, rendered pliable by immersion in hot water, are applied. These are fixed in position with bandages completely saturated with starch. Some operators prefer to omit the cardboard splints. The gravest disadvantage, however, of this dressing consists in the fact that it requires twenty-four hours to become thoroughly hard. Starch may advantageously be replaced by ordinary glue, prepared as for carpenters' use. Dextrin bandages are applied like starch bandages but are somewhat dearer. The hardening mixture is usually composed of: Dextrin 100 parts, spirit of camphor 60 parts, water 500 parts.

Glue bandages are sometimes used, but harden rather slowly. Bandages or strips of linen are smeared on one side with melted glue, dried, and rolled up with the dressed side outwards; they are immersed in hot water just before application. Another method consists in thoroughly saturating ordinary bandages in hot thin glue immediately before use.

Pitch bandages are prepared by drawing long strips of linen through fluid pitch and hanging them up to cool. In use comparatively short lengths are applied at one time as each must be softened and made adhesive by warming. They are extremely unpleasant to handle.

Water glass is utilized for permanent dressings by painting an ordinary bandage with a solution of water glass as each turn is applied, or a very loosely rolled bandage may be saturated with the fluid before use. This dressing hardens more quickly than starch, but not so rapidly as plaster or tripolith. It is, however, lighter and more elastic than plaster. Water glass solution, when mixed with chalk, magnesite, Portland cement, etc., produces a stronger dressing, which also hardens more rapidly.

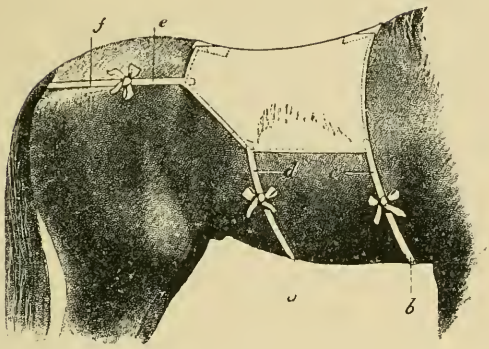


FIG. 216.

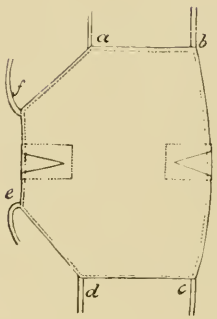


FIG. 217.

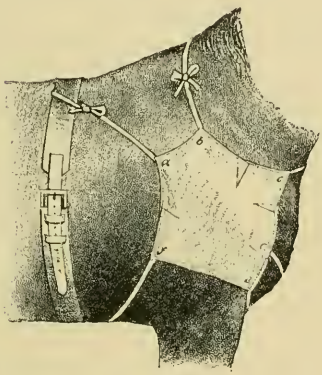


FIG. 218.

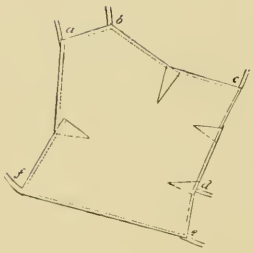


FIG. 219.

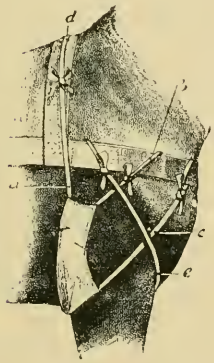


FIG. 220.

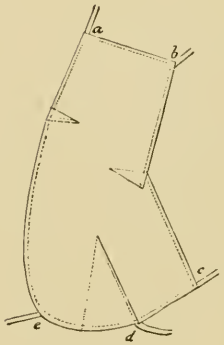


FIG. 221.

The most generally useful, however, are *plaster and tripolith bandages*. Modellers' dry plaster is rubbed into ordinary loosely woven bandages which are then rolled up, care being taken that as large a quantity as possible of the plaster is retained in the material. Just before use they are saturated with water (preferably containing a little dissolved alum, which hastens setting); they are then gently squeezed and at once applied to the parts, which have previously been padded as above described. The first folds should be applied around the free extremity of the limb and bandaging continued upwards, care being taken not to use much pressure. The piece of linen placed next the skin should extend beyond the limits of the bandage so that when the latter is complete the edges of the linen can be turned up after the manner of a cuff, enveloping the wadding or other padding material. This gives the dressing a rounded edge, and prevents any pressure on or rubbing of the skin. After complete application the surface of the dressing may be smoothed with the wet hands, or some thin plaster may be spread over it and smoothed off. Depending on its thickness the bandage sets in from fifteen to thirty minutes, during which time extension or flexion of the limb must be prevented. Plaster of Paris, if long kept or allowed to become damp, sometimes fails to set, but a little care in storage will prevent this. If desired, setting may be delayed by adding glycerine to the water used in mixing the plaster. To further support the dressing thin pieces of wood or splints of zinc or tinned iron may be inserted between the layers.

Hertwig suggests oiling the skin, and slipping over the limb an arrangement resembling the leg of a pair of drawers into which thin plaster is poured. This might certainly be tried under very special circumstances, and would appear to promise security against irregular local pressure, but though attractive in theory would probably prove extremely difficult to carry into practice. Moreover, should swelling tend to occur at any point the unyielding character of the dressing might cause very serious results.

Instead of pure plaster a mixture of one part cement to two or three parts of plaster has been recommended. It appears to present no special advantages.

Tripolith, a grey powder of unknown composition, is sold commercially. It hardens in much less time than plaster, and has the advantage of keeping well, even in open vessels. Dressings made with it are lighter and cheaper than those made with plaster, but as it hardens so very rapidly only one or two bandages should be moistened at a time.

All the above dressings can be made waterproof by varnish or shellac

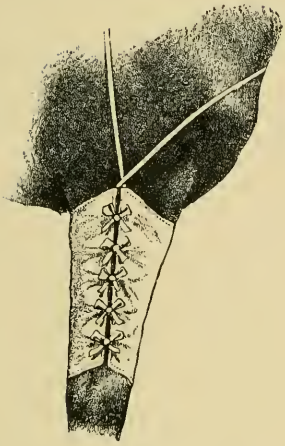


FIG. 222.

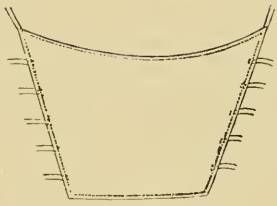


FIG. 223.

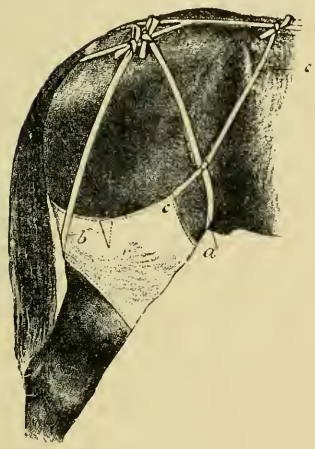


FIG. 224.

FIG. 225.

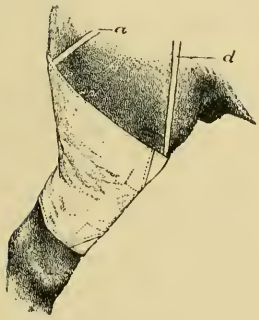


FIG. 226

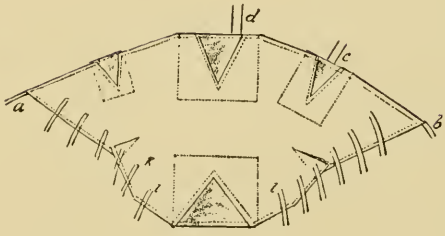


FIG. 227.

solution, which also gives them greater durability. While the plaster is setting it is absolutely necessary that the limb should be retained in the proper position, as any movement breaks and therefore usually entirely spoils the dressing. For this reason small animals must be kept lying; larger animals should be placed in slings.

Fig. 228.

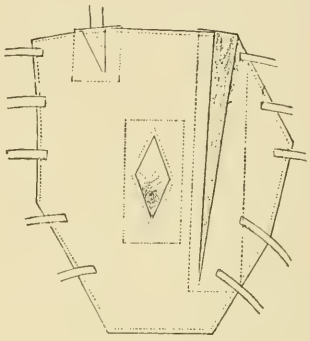


Fig. 229.

These dressings, especially when of plaster, are often very difficult to remove, especially if one wishes to remove the bandage in two parts so as again to utilize it. To facilitate the operation special scissors have been designed, but they are very costly and rapidly become worn,

Fig. 230.

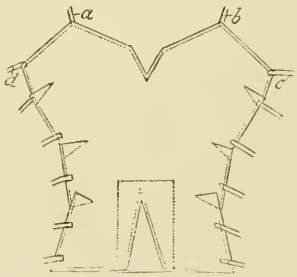


Fig. 231.

while the same object can be attained almost as well, though somewhat less rapidly, with a strong pocket-knife, the line through which the incision is to be carried being first thoroughly moistened with warm water or, better still, with hydrochloric acid. In the latter case of course, the instrument used for cutting suffers very considerably.

Gutta-percha dressings are less frequently employed in veterinary surgery on account of their cost. The material is in the form of flat plates, which become plastic on immersion in warm water, and can then be pressed closely in contact with the injured part, which should first be well oiled. The soft mass adapts itself with the greatest facility to all prominences and depressions, and rapidly becomes hard under a stream of cold water. The advantages of gutta-percha are its slight elasticity, the ease with which it can be kept clean, its impermeability to fluids, and the facility with which it can be removed. Moreover, the same material may be used repeatedly, so that its first cost is really the chief objection. For small animals like dogs it is particularly useful, and in fracture of the lower jaw in larger animals it renders excellent service, a kind of hollow splint being formed, in which the jaw is embedded.

Poroplastic felt consists of felt impregnated with a resinous solution. It is made in sheets of varying size and thickness up to three feet square and $\frac{3}{8}$ inch in thickness. By immersion in boiling water or exposure to dry heat it becomes quite plastic, and may readily be moulded to the shape of the injured part. It becomes firm on cooling, but a "setting" process continues for some time afterwards, so that its greatest strength is not attained for six or eight hours. Its porous character readily permits of transpiration, and the skin is therefore much less apt to become macerated by retained perspiration, as occasionally happens when gutta-percha splints are used. The writer has seen very excellent results from the use of this material in the setting of fractured limbs in racehorses.

CHAPTER XIV.

MASSAGE.

The term massage includes various forms of mechanical treatment, which, according to the demands of the case in question, are either applied singly or in combination, in order to bring about particular curative results. The terms mechanical treatment and mechano-therapy have also been coined, but the word massage is much more frequently employed, and therefore understood. We may distinguish—

1. Gentle stroking of the diseased parts with the fingers or open hand in the direction of the flow in veins and lymph vessels, that is, from the periphery towards the centre. The maximum pressure to be applied in such case should at first not exceed that produced by the weight of the operator's hand.

2. Brisk rubbing or pressure followed by stroking from the periphery towards the centre.

3. Beating of the parts with the open hand or fist, or with the edge of the hand, or a special percussion hammer.

4. Kneading, in which the affected part, usually a muscle or tendon, is lifted as high as possible with one hand, and then squeezed in precisely the same manner as one would press out a moist sponge to squeeze out its contents.

5. Active and passive movements.

To prevent formation of pustules at the roots of the hair, which would put a stop to further massage, it is usual in human practice to shave the affected spot and coat the parts with some lubricant, but this is not absolutely needful. According to the effect produced massage is applied for periods extending to an hour or more daily, provided, of course, that the reaction in the affected parts permits of

it. In the intervals the patient himself has to carry out certain movements with care. At first massage generally causes pain, which, however, disappears on each occasion during the process, and is replaced by a pleasant feeling of warmth, flexibility, and increased power in the parts.

From the above it will be seen that massage favours increase of bodily strength and endurance, but its best effects can only be obtained by practice and by a thorough knowledge of the pathological processes to be combated, the exact anatomy of the diseased parts, and the physiological effects of the different massage manipulations. Experiment shows that the effects vary, similar manipulation being irritant or soothing, inclined to produce or to dissipate inflammation, and to alleviate or arouse pain, according to the personal idiosyncrasy of the patient. The operator must first clearly conceive the changes he desires to effect in the diseased parts, as only then can he reasonably expect to effect improvement, or even to know whether massage is likely to be of benefit apart from choosing the exact system to be followed in the case in question.

The action of massage depends on its favouring and increasing absorption, accelerating circulation, and relieving pain. By stroking centripetally, not only is circulation in the collecting vessels locally stimulated and tension relieved, but mechanical congestion in parts removed from the centre is lessened, and exuded lymph absorbed, while accumulated exudates and extravasations in the tissues themselves are distributed over a larger area, are brought in contact with numerous absorbents, and are mechanically assisted in entering them. For these reasons it is best to commence not at the diseased spot itself but on the central side of it, and gradually to approach the diseased spot in order to first clear a space, into which the exudate or extravasation may more readily flow.

Mosengeil's experiments prove it possible to remove fluid even from joints by pressure and stroking. He injected Indian ink into the synovial cavities of rabbits, and in two or three minutes reduced the joints to their normal form by massage. On *post-mortem* examination the Indian ink was found in the nearest lymphatic channels, vessels, and glands.

Massage promotes active resorption, diminishes swelling of tissues, and therefore pressure on the sensory nerves they contain, a fact partly explaining the decrease of pain. Massage also directly stimulates nerves, at first increasing, but afterwards diminishing their irritability. Newly formed adventitious tissue and vessels may be broken down by powerful pressure and rubbing. The

extravasate thus produced, together with the cells of the broken down tissue, may be rapidly absorbed.

Infiltrations, even of cartilaginous hardness, may be dispersed by repeated and long continued massage, and callus formations, so long as they are not of bony hardness, may be markedly diminished.

Muscles are stimulated to contraction, which, as is well recognised, constitutes an important factor in favouring absorption. Not only healthy but relaxed and semi-paralysed muscles again respond to stimulation, as shown by the electric current, a fact explained by the increase in supply of nourishment to the part. Muscular exhaustion following exertion is soon removed by kneading, both because metabolic products which accumulate in muscles during work are more rapidly absorbed, and because at the same time nutritive material is brought to the parts. The capacity of the muscle for exertion may even become greater than it was before the period of exhaustion set in.

Massage is of special service in diseased conditions dependent on hyperæmia, extravasations, exudations, thickening of tissue, adhesions, in short, on the results of non-specific inflammation, the products of which therefore not being of bacterial origin may be absorbed into the blood without producing bad results.

Considering now for a moment the relation between the individual manipulations in massage and the varying diseased conditions to which they may be applied, we find that stroking is specially indicated for the removal of extravasations and inflammatory products, and usually forms the best conclusion to more vigorous manipulations. Rubbing benefits cases of partially organised inflammatory products, infiltration of muscles, distension of tendon sheaths, commencing new bony growths, etc. Kneading is recommended for inflammatory swelling of muscles in muscular rheumatism, and in inflammation and thickening of tendons. The parts are percussed or gently struck in order to arouse or depress nervous sensibility. The most remarkable effects have been claimed for an electric "vibrator" which inflicts several hundred slight blows per second on any given part. The number and strength of these blows can be regulated within very wide limits.

Massage is largely applicable to animals as well as to man. We have to deal with many forms of inflammatory swelling resulting from pressure, thickening of the skin and subcutaneous tissue of the extremities, bruising of the margins of joints, the early stages of exostöses, periostitis, inflammation of tendons and tendon sheaths, adhesions of tendons, etc., to one another or to neighbouring tissues, distension of synovial and mucous bursæ, induration of the udder, impaction of the bowels, tympanites, etc. In the treatment of most of these

diseases friction, which we must now regard as a kind of massage, has been utilised since ancient times. It is true that the stroking or rubbing is as often as not in the opposite direction to that of the circulation, and absorption, if occurring, must take place by collateral paths, inasmuch as the diseased spot lies between the material which is thus pressed towards the periphery and the centre of circulation. Furthermore, rubbing differs from stroking, inasmuch as considerable pressure is employed, and new tissue and recently formed vessels may quite possibly be broken down, the further changes then occurring as above noted. The same is true of the system of pressing on and rubbing recent exostoses with a flat piece of wood, which was customary in former times, but the comparative inefficiency of this rudimentary massage lies not so much in the fact of the operator failing to observe the proper direction as in his altogether neglecting treatment until far too late, until, in fact, the products of inflammation had become completely organised.

As long ago as 1880 Bayer pointed out in his first publication on massage that in our practice we cannot expect the extensive and successful application of massage which obtains in man. We have already noted that in man the hair is removed and the skin lubricated to prevent pustular eruption. In animals, however, we cannot shave an entire limb, and even if the hair were removed we are able to apply massage in the proper centripetal direction only in a few places, like the neck and back; at almost all other spots where massage is to be employed we are forced to work against the direction of the hair, which is very difficult. Bayer attempted to overcome this difficulty by the use of massage rollers consisting of small hollow cylinders covered with, or entirely constructed of, rubber. Such instruments, however, cannot replace the hand, which so readily adapts itself to the varying contour of the body and allows so much more perfect an estimate to be formed of the pressure employed than can be obtained in any other way. The exact degree of pressure to be used is difficult to judge, and can only be learned by practice and experience. Excess causes injury and delays improvement, as one often sees when the treatment has to be left in lay hands. Bayer prefers to forego massage altogether rather than leave the manipulation to the owner or coachman. The pain caused by pressure and kneading, especially where much force is employed, sometimes renders it necessary to resort to means of restraint. The action of massage is considerably increased by substituting for mere lubricants ointments containing substances which promote absorption.

Active and gradually increasing exercise produces similar results.

chiefly by improving blood and lymph circulation and increasing metabolic changes.

Massage being applicable in a large number of animal diseases and their sequelæ, we may briefly consider those in which it seems more particularly indicated. In infiltration of the cornea with milky deposit, not due to cicatricial formation, massage is applied in the form of circular and radiating rubbing. As horses with disease of the eye usually resist interference. it is necessary to proceed with caution. The hand is first passed over the side of the face furthest removed from the eye and gently advanced more and more closely to the diseased eye. Placing the points of the index and middle fingers very lightly on the upper eyelid the lid is caused to move over the surface of the cornea with circular and radiating movements. Very good results may be obtained in this way alone, but a small quantity of some resorptive ointment, like the yellow or red oxide of mercury ointment, may, in addition, be introduced into the conjunctival sac. Bayer also recommends iodoform ointment and iodoform in powder.

Massage is particularly valuable in inflammation of tendons and in recent cases of thickening of the tendon, but only when the condition is circumscribed. When the entire tendon is thickened the effect is much less satisfactory. On the other hand, excellent results may be obtained in thickening of the flexor pedis perforans, though considerable patience and perseverance are required. The foot being lifted, the upper part of the thickened spot is grasped between the thumb and fingers and kneaded, at first very gently, afterwards more strongly, but without excessive pressure. The operator gradually works further down. Manipulation being complete, the horse is exercised for a short time and a wet bandage applied.

In dispersing the soft enlargement resulting from periarthritis the thumbs are most employed. The periphery is first manipulated, the thumb being applied to the soft tissue with considerable pressure. This tends to break up the soft deposit, which is then further dispersed by powerful stroking movements with the thumb. The horse is afterwards exercised. Passive movement of the joint can only be carried out satisfactorily in small animals.

Vogel recommends massage in various diseases of the udder. Old practitioners appear to have recognised its good effects, as shown by their advising frequent milking, which really acts as a kind of massage. Vogel, however, lays stress on the suggestion that the veterinary surgeon himself should first carry out the operation, because rough or excessive manipulation often causes a relapse. The hard masses of tissue are grasped and kneaded or rolled under the fingers. This

manipulation is sometimes so painful that some means of control are required.

Massage of the abdomen is most useful in ruminants and dogs. In ruminants it arouses peristalsis, so that in fifteen to twenty minutes the overloaded and torpid rumen may often be set in action. The best method of manipulation is to station on either side of the abdomen a man who, laying his clenched fists close together on the animal's side, makes regular powerful kneading movements from below upwards. Where severe tympanites or obstinate chronic impaction of the omasum exists, or rumination has been suppressed for several days, the power of the operator's arms is insufficient, and Vogel suggests the operator sitting on a stool and using the soles of the feet. Counter-pressure must, of course, be exercised on the right side.

In dogs the abdomen can be massaged with the animal either in the upright or prone position. The points of the fingers alone may be used, or where over-distended portions of the bowel can be felt the open hands may be employed. The coil of intestine is grasped with the fingers and the contents broken down and forced onwards. With the animal in the standing position one operates in a similar way, the points of the fingers being slowly pressed from either flank into the depths. The individual portions of bowel may be kneaded and peristalsis aroused by suddenly releasing the parts after subjecting them to steady pressure. In this way even severe constipation may be cured and more serious operation often avoided.

CHAPTER XV.

CASTRATION.

For economic reasons, the removal of the testicles or ovaries, or the destruction of their functions, often becomes necessary. The gelding is, for most purposes, more useful than the stallion: its formation is modified, it is usually more tractable, and it can be worked in company with mares, a proceeding which is seldom safe in the case of stallions. The flesh of pigs and birds becomes more palatable, and the animals fatten more readily after castration. Sheep fatten more quickly, and their wool becomes finer and more abundant. The milking period is prolonged in the castrated cow, and the danger of unsuitable animals breeding is removed. Dogs are less liable to stray, and bitches cease to attract strange dogs. Finally, certain diseases of the generative organs are sometimes cured by operation. Thus in man castration has been employed for the reduction of enlarged prostate, and in the dog operation for the same object was suggested by Dr. Clarke (see 'Veterinarian,' 1895, p. 431). More recently Professor Hobday claims to have had success in this direction. The pathological enlargement of the gland gradually diminishes. In man osteomalacia is said to have been beneficially affected by castration, but how far the procedure is likely to succeed in animals remains to be proved. On the other hand, "spaying" in cows often removes nymphomania. Castration is also indicated by the presence of malignant tumours and fistulæ, and in certain injuries of the testicles, in inguinal hernia, and in the disease known in France as *maladie du coit*.

Castration seems to have been performed on animals since the earliest times, and is still an exceedingly common operation.

Owing to the essentially different methods of procedure in male and female animals, castration will be treated of separately in each sex.

Castration of Male Animals.

Experience shows that male animals are best castrated young. Many of the advantages claimed for operation, such as the change in bodily form, are lost when it is too long deferred.

Excluding the first few weeks of life, most domesticated animals undergo operation during the first year. The horse is an exception, because in it the testicles lie within the inguinal canal during part of the first year, towards the end of which they usually descend into the scrotum, and so become readily accessible. Moreover, horses castrated during the first year often assume a female type, whilst those in which operation is deferred develop to a greater extent. Nevertheless, animals can be, and racehorses sometimes are, castrated before the expiration of the first year in order to hasten the advent of their period of usefulness. The operation then resembles that on inguinal cryptorchids.

Anatomy.—The testicles, removal or disabling of which is aimed at in castration, are suspended in the scrotum by means of the testicular cords. The scrotum and the structures it encloses may be divided from without inwards into the following layers :

1. The outer skin. This is soft and thin, usually hairless, in the horse black and shining ; it is very extensible, and is directly continuous with the common integument. In ruminants the scrotum shows a distinct neck ; the skin covering it is light coloured, and exhibits little hair. In swine the scrotum, which is broad and smooth, lies between the hind quarters, close under the anus ; in carnivora it is somewhat further forward.

2. Beneath and intimately connected with the skin is the tunica dartos, which consists of a modified subcutis abundantly supplied with unstriated muscular fibres, elastic and white fibrous tissue. Above it is connected with the yellow elastic abdominal tunic, while a prolongation of the tunica dartos, the septum scroti, serves to divide the scrotum into two equal portions. Strictly speaking, the skin and tunica dartos together form the scrotum.

3. The spermatic fascia, continuous with the tendon of the external oblique muscle.

4. The cremasteric fascia, continuous with the internal oblique muscle.

5. The infundibuliform fascia, continuous with the transversalis muscle.

6. The tunica vaginalis reflexa, a layer of serous membrane continuous with the abdominal peritoneum.

Professor McFadyean remarks of layers 3, 4 and 5 that the dissector will probably be unable to discriminate between them. These three layers, being adherent, are often referred to by Continental surgeons as the processus vaginalis communis or common vaginal sheath. Though anatomically incorrect, this method of regarding the three coverings is sometimes convenient to the surgeon as obviating a lengthy description. The tunica vaginalis reflexa is sack-like in form: above, where it lies in the inguinal canal, it is much narrower than below, where it surrounds the testicles. Its narrowest point is rather more than an inch below the inner inguinal ring, thence it gradually dilates as it descends; as a whole its outline resembles that of an hour glass. In the space enclosed by this prolongation of the vaginal tunic are found the testicle and spermatic cord; in the horse the testicle lies horizontally, in ruminants vertically, with the epididymis pointing downwards.

7. The testicular cord is a flattened, longish, fan-shaped structure, connected at its lower, broader end to the testicle, whilst its upper portion extends into the abdominal cavity. It is invested by the visceral layer of the tunica vaginalis, a prolongation of the visceral peritoneum, and consists of the following parts:

(*a*) The vas deferens, which is placed at the posterior part of the spermatic cord, is a thick-walled tube, representing the excretory duct of the testicle, in large animals of the size of a goose-quill, surrounded by a fold of peritoneum and situated on the inner side of the spermatic cord; by its convolutions it forms the epididymis, the anterior enlargement of which is termed the *globus major* on account of its greater size, the posterior the *globus minor*; the intermediate part is called the *body*. The vas deferens enters the peritoneal cavity through the inguinal canal, passes backwards, surrounded by a special fold of peritoneum, towards the upper surface of the urinary bladder and empties by the ejaculatory duct into the urethra.

(*b*) The spermatic vessels and nerves. The spermatic artery lies in the front part of the spermatic cord and is accompanied by the large and tortuous spermatic veins, the convolutions of which form the plexus pampiniformis. The upper portions of the vessels pass, enveloped in a fold of peritoneum, from the inner inguinal ring to the posterior aorta and the posterior vena cava respectively.

The anterior portion of the cord (the vascular portion) therefore contains the important blood-vessels, whilst the posterior is comparatively poor in vessels, a point of great importance in connection with castration. The parietal layer of the tunica vaginalis, which surrounds the spermatic cord just as the parietal layer of peritoneum surrounds the abdominal viscera, extends from the posterior wall of the vaginal space to the posterior septum of the spermatic cord, and thus binds the cord to the scrotum.

The inguinal canal consists of a flattened, funnel-shaped space between the abdominal coats, communicating above through the medium of the inner abdominal ring with the peritoneal cavity, and below by the outer abdominal ring with the interior of the scrotum. The outer abdominal ring, an oval opening between the inner and outer

limbs of the tendon of the external oblique abdominal muscle, can be enlarged by drawing back the hind limb of the corresponding side. The ring can then be felt by passing the hand gently upwards along the inner surface of the thigh and some estimate of its size can be made, a matter of importance under certain circumstances.

In the horse the inner abdominal ring is an opening about $\frac{3}{4}$ inch to $1\frac{1}{2}$ inches long, between the posterior border of the inner oblique muscle and the reflected portion of the external oblique tendon, *i.e.* Poupart's ligament; it lies just in front of the transverse portion of the os pubis, inclined obliquely forwards and outwards; $\frac{3}{4}$ inch nearer the middle line lies the subcutaneous abdominal artery.

Castration does not necessarily imply removal of the testicles. The function alone of the testicle can be destroyed, but as the process is necessarily less certain than that in which the testicles are removed, the latter is very generally preferred. No description of the subject, however, could reasonably be regarded as complete which omitted reference to the former method. A short description will first be given of

I. *Castration without removal of the testicles.*

1. Crushing the Testicle.—A method formerly used, especially in Spain, consisted in first applying clams to the scrotum and then crushing the testicles singly by blows from a wooden hammer. Violent inflammation was thus produced which ultimately led to degeneration and loss of function of the testicle. Apart from the uncertainty of the result, the method was barbarous and painful in the extreme. The same is true of the system of perforating the testicle with a glowing iron.

2. Crushing the Spermatic Cord.—The neck of the scrotum was included in wooden clams which were hammered for several minutes with a wooden hammer. The operation was usually performed on calves. When successful, the testicles gradually became atrophied in consequence of thrombosis of the spermatic vessels. Steers are still castrated by this method in India. The operator strikes the spermatic cord, which is supported by a wooden block, several times with a wooden hammer. The operation, if it may so be called, is also performed on sheep and goats, the reason of its adoption being the danger in a hot climate of inflicting surgical wounds and the fact that after-treatment is thus dispensed with.

Siebold recommends a somewhat similar method for bulls and goats. A wooden clam, about 8 inches long and $1\frac{1}{4}$ inches wide, provided with a screw for closing it, is applied tightly to the neck of the scrotum for several minutes. The scrotum remains intact but the spermatic

vessels become thrombosed, and in from three to ten weeks the testicles atrophy. On slaughter of animals thus treated the spermatic vessels are found blocked. The method is still sometimes used in calves.

3. Torsion of the Spermatic Cord was formerly much employed in France for bulls, and is known as *bistournage*. The animal's head was fastened up tightly and the operator, standing behind the animal, grasped the scrotum in both hands and drew one testicle as far backwards as possible. On releasing the scrotum the testicle was drawn upwards. By repeating this manœuvre several times the cremaster muscle was temporarily paralysed and could no longer retract the testicle.

As soon as this result was attained the spermatic cord was grasped close above the epididymis with the thumb and first and second fingers of the left hand, while with the fingers of the right hand the testicle was rotated, the lower end being brought to the top. In this position the testicle was grasped with both hands, rotated several times on its long axis, and then thrust into the inguinal canal. The remaining testicle was similarly treated and a ligature applied around the scrotum close to the outer abdominal ring and left in position for forty-eight hours. At first some swelling developed but soon afterwards disappeared, and the testicles underwent atrophy. The original procedure, which in practised hands scarcely required five minutes, has since been repeatedly modified, and has been practised on horses. Morot recommends rotating the testicles from 6 to 9 times in bulls and 9 to 12 times in rams, and then to allow the testicles to resume their natural position; the application of a ligature is unnecessary. The animals are said to show less pain and can at once be returned to pasture. This method, however, requires more exertion and skill on the part of the operator.

4. Subcutaneous Ligation of the Spermatic Cord was first recommended by Martin for bulls, rams, and dogs. It is well adapted for castrating goats provided antiseptic precautions be observed. The animal is placed on its back and its legs are held by two strong assistants; the hair is shaved away from either side of the neck of the scrotum and the skin disinfected *secundum artem*. The spermatic cord of one side is then thrust against the outer wall of the scrotum by means of the finger and thumb and a tolerably strong silk thread passed from behind forwards through the neck of the scrotum on the inner side of the spermatic cord by means of a needle about two inches long. The free end of the silk thread is then passed through the eye of an otherwise similar but *blunt*-pointed needle which is returned, first through the

point of exit, then through the scrotum on the outer side of the spermatic cord, and lastly through the point of entry. The thread thus forms a loop surrounding the spermatic cord. The two ends are tightly tied together, the loose portions snipped off close above the knot, and the ligature allowed to pass into the scrotum; the little puncture is painted with iodoform collodion. The other spermatic cord is treated in precisely the same way. Provided proper care be taken regarding antisepsis neither inflammation nor suppuration occur and the animal seems to suffer comparatively little. The testicles swell somewhat during the next few days, but atrophy commences in from three to four weeks and the glands gradually and almost completely disappear. Möller states that ligation is followed by necrosis as he ascertained by experiment. To avoid the use of two needles Schmey invented a needle with the eye near the point and a screw-joint in the centre of the shank. The silk thread was passed as usual on the inner side of the cord, after which the two portions of the needle, enclosed within the scrotum, were unscrewed, the spermatic cord pushed between them, and the needle again united and withdrawn. Failing this needle or even a sharp and a blunt needle, the ligature may be returned by using the blunt end of an ordinary needle, *i. e.* by simply using the needle reversed during the second portion of the operation. Asepsis is not difficult of attainment if properly sterilised silk be used. Goats being rather prone to complications after ordinary castration, with incision of the scrotum, this method deserves consideration. The ligatures must, however, be drawn very tight, otherwise the operation fails and the activity of the glands still continues.

In operating on bulls the hind limb on the side selected should be drawn forward so that the operator, by kneeling down, can grasp the neck of the scrotum. The operation is otherwise similar to that above described.

Dentler recommends subcutaneous, or better still intrascrotal, section of the spermatic cord for calves and goats, but the method has not been well received by most practitioners on account of the danger of bleeding, suppuration, and other troublesome complications.

That sexual impulse is not removed by ligation of the vas deferens alone is shown by the following experiment. One sometimes finds cryptorchids in which the epididymis lies in the inguinal canal while the testicle itself is in the abdomen. In one such case Möller ligatured and snipped off the epididymis without removing the testicle. The

passage of semen then ceased but sexual desire remained as before until by a second operation the testicle was removed.

II. *Castration by Removal of the Testicles.*

At the present time the commonest method of castrating horses, bulls, and carnivorous animals is by removing the testicles. The testicles are removed either alone or with portions of the scrotum, though the latter method is only usual in calves and goats, where a ligature is passed round the neck of the scrotum. A running noose is formed in a strong piece of cord, slipped round the upper part of the scrotum and drawn tight. Provided it be drawn sufficiently tight in the first instance the scrotum and its contents fall away in from eight to fourteen days, otherwise the loop must again be tightened. Wooden or iron clams have been used to replace the ligature. Both methods inflict needless pain and are seldom used except in calves, which, however, also suffer much more from clams or ligatures than from the more surgical method of opening the scrotum. Piot claims to have castrated two thousand bulls in Egypt without loss by using the elastic ligature, which is also valuable in the case of goats. The operation is easy and rapid and involves no loss of blood. The elastic cord is applied in a stretched condition, the ends are tied, and the testicles cut away about an inch below the ligature. Care must be taken to prevent the animals licking or gnawing the ligature which might thus be torn away.

Castration by removal of the testicles is accompanied by various dangers, which must be carefully kept in mind when operating. They are :

1. Hæmorrhage from the spermatic vessels, which under certain circumstances may prove fatal.

2. Infective inflammation of the spermatic cord, which almost always follows opening of the scrotum and may extend to the peritoneum, causing fatal peritonitis. Owing to uncontrollable circumstances aseptic healing is seldom possible, and therefore specific infection, *i. e.* infection with septic organisms, is not always avoidable, though proper precautions in regard to cleanliness and drainage usually prevent it.

3. In those forms of operation in which the tunica vaginalis is opened, some danger of prolapse of bowel or omentum always exists. As a rule, however, such an accident only occurs when the inner abdominal ring is unusually dilated, or when inguinal hernia exists, for

which reason the scrotum and outer abdominal ring must always be carefully examined prior to operation.

The commonest methods of dividing the spermatic cord are:

1. Tearing Away of the Testicles.—This method is still extensively used in the case of calves, lambs, and swine; after opening the scrotum the testicle is grasped and forcibly torn away. In countries like Russia and Australia, where very large numbers of lambs have to be castrated, the system is still followed; lay castrators in South Germany also continue its use. Should the central portion of the cord not be firmly held, however, the fold of peritoneum which surrounds the spermatic vessels within the abdomen is torn across or the divided end of the cord is withdrawn into the abdomen, where it becomes adherent to the peritoneum near the inner abdominal ring; in either case the bowel may be incarcerated, with fatal results ("guttie").

2. Scraping the Cord is most commonly practised in young animals, and in swine and sheep. After opening the tunica vaginalis, the cord is laid across the left index finger and scraped with a blunt knife until divided. The blood-vessels are thus torn, and bleeding is usually trifling. Dawson and Hurford have successfully employed this method with horses; the posterior portion of the cord was simply cut through and only the vessels were scraped.

3. Crushing by Means of the Écraseur.—During recent years many English and American practitioners have adopted the écraseur for castrating stallions, the chain or loop of the écraseur being passed round the spermatic cord, which is slowly crushed. The écraseur has also found increased favour in Germany, Belgium, and other countries.

In England an instrument known as the emasculator is now largely used. Its construction, however, is more complicated than that of the écraseur, and it is therefore more difficult to keep clean.

4. Torsion of the Spermatic Cord.—In performing this operation the posterior half of the cord is divided with a knife, and the anterior, containing the blood-vessels, is twisted round its long axis until it ruptures. In horses and bulls, after opening the scrotum and applying a clam or pair of forceps just above the epididymis, in order to fix the vascular part, the cord, together with the testicle, is removed by rotating the testicle and cord either with a second pair of forceps or with the hands. In sheep, swine, and carnivora, the spermatic cord is fixed between the thumb and the fore-finger of the left hand, while the testicle is rotated with the right hand; the simplest method, after dividing the cremaster muscle with scissors, being to thrust the index finger of the right hand through the centre of the cord immediately

above the epididymis, and using the incision so made as a means of grasping and rotating the cord.

The most popular of the older forceps for fixing the spermatic cord is Tögl's, which is made of two different sizes, one for horses and bulls, and one for small animals. Its original form has been variously modified by different operators. Möller uses smaller forceps provided with longer limbs, which give greater leverage and are easier to hold. In France Renault's forceps are most used. In England, Robertson suggested a special form of torsion forceps,

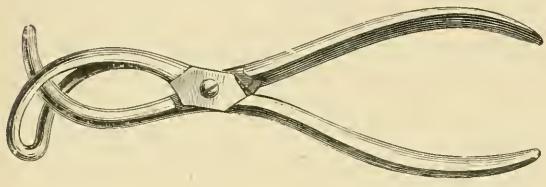


FIG. 232.—Tögl's forceps for holding the spermatic cord.

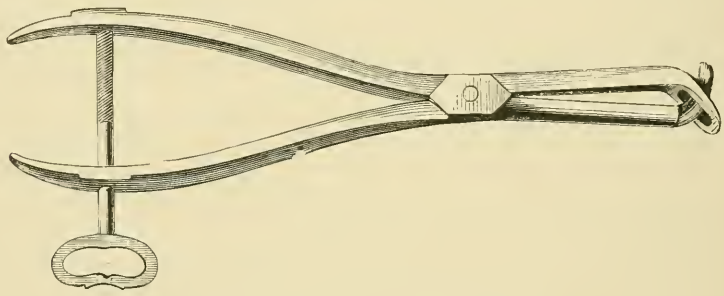


FIG. 233.—Kaiser's forceps for holding cord.

which has been adopted by Möller. In former times iron clams were used instead of forceps.

In torsion of the spermatic cord it is naturally of importance to

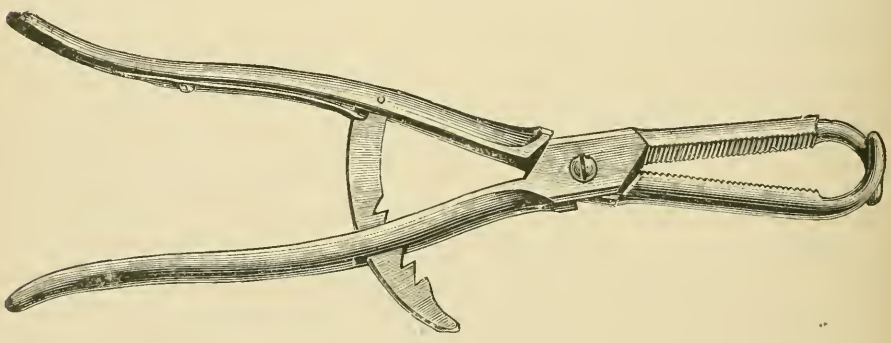


FIG. 234.—Möller's forceps for holding cord.

produce entire closure of the blood-vessels. This is partly secured by firmly compressing the portion of the cord grasped in the first pair

of forceps, and thus crushing the walls of the blood-vessels, a condition favoured by roughening the jaws of the forceps, and partly by rotating the second pair of forceps very slowly, in which case the blood-vessels are the last parts to be torn through.

Most forceps are defective, inasmuch as they take too broad a hold of the spermatic cord, and thus render the effects of torsion irregular.

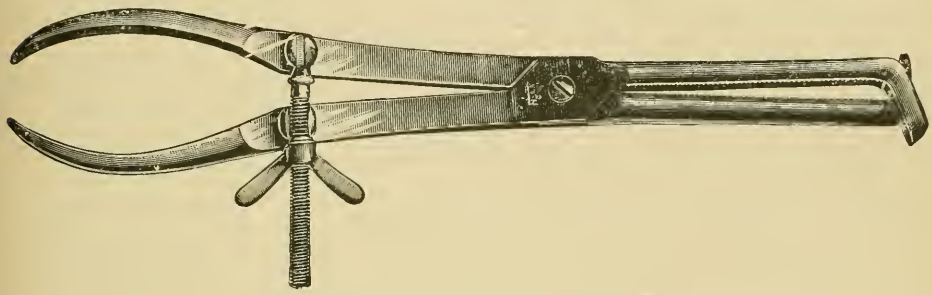


FIG. 235.—Bayer's forceps with screw and instantaneous release. For holding the cord.

The anterior and posterior margins of the spermatic cord are torn through after the second forceps has been turned once or twice, and the blood-vessels are divided without having first been sufficiently twisted. Bleeding is then very liable to occur, especially if a second forceps be used for turning, and if the hold on the spermatic cord be too short. To ensure regular torsion the spermatic cord should first be rolled together into a cylindrical mass, as occurs in using Tögl's forceps. The blood-vessels thus become the last portions to rupture, and only yield after prolonged twisting. The torn portions of the spermatic cord apply themselves around the lumen of the vessels, which they completely close, so that no bleeding occurs. As, however, with Tögl's ordinary forceps it is difficult to compress the spermatic cord sufficiently, the handles have since been much lengthened and the jaws shortened, a modification which has greatly increased their efficiency.

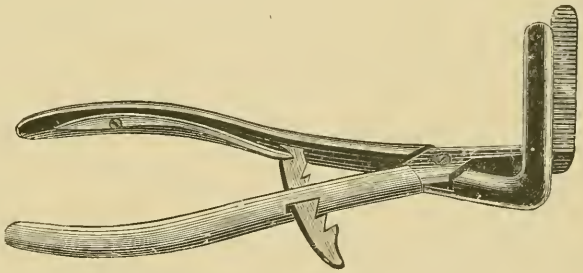


FIG. 236.—Robertson's forceps for torsion of the cord, as adopted by Möller.

The cord should be rotated quite slowly. The testicle is grasped with the hands, or with a second forceps, and regularly and slowly

turned until the spermatic cord tears through. As a rule fifteen to twenty turns are necessary, sometimes even more. Where a second forceps is used for twisting it should not be applied too near the first, a space of $\frac{3}{4}$ inch or $1\frac{1}{4}$ inches being left between the two.

After dividing the non-vascular portion of the cord with scissors the best method is to grasp the vascular part about $\frac{3}{4}$ inch to $1\frac{1}{4}$ inches above the epididymis with forceps, and compress it firmly. The testicle is then grasped with both hands and rotated as above described. The vas deferens breaks first, whilst, on account of their greater elasticity, the blood-vessels, especially the spermatic artery, are the last portions to yield. Special care is therefore needed towards the latter part of operation. The vessels should never be torn through, but torsion should be continued until the cord is completely divided. By pulling

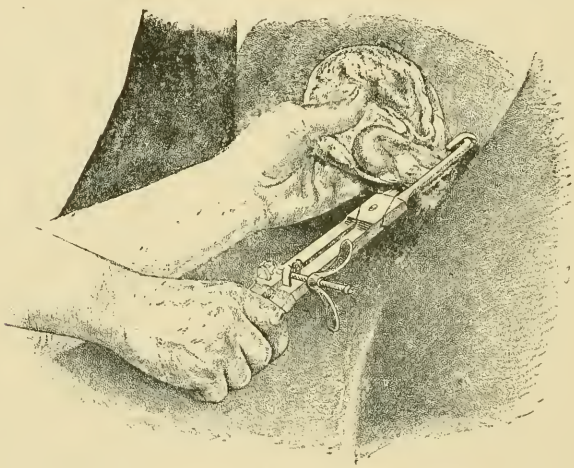


FIG. 237.—Bayer's forceps in use. Many operators prefer Tögl's forceps, which roll the cord together into a cylindrical mass (see text).

on it the elastic artery is drawn from within the shelter of the other tissues, and being no longer surrounded and supported by them, is apt to bleed. The vessels having been twisted through, the testicle is placed on one side, and the fixation forceps slowly and cautiously relaxed. Should bleeding occur the forceps are again closed, the bleeding vessels grasped with Wells forceps and twisted, or ligatured with the above-mentioned precautions. Should the bleeding cord slip beyond the forceps, it may be regained by first seeking the processus vaginalis, and passing the fingers within. After operation is complete care must be taken that the cord returns within the processus vaginalis, and that the edges of the scrotum are drawn somewhat downwards.

5. Ligation of the Spermatic Cord, that is, of the anterior vascular portion, has been repeatedly recommended by various operators. At first sight this method appears the most natural and surgical; nevertheless it has not found general acceptance. Even those operators who first recommended it have since given it up. It is certainly not suitable for all species of animals, and although carnivora and old boars can readily be castrated in this way, and although with certain precautions the method is also practicable in ruminants, yet it cannot be recommended for horses.

In this operation the spermatic cord is exposed, the non-vascular portion divided with scissors, and after ligaturing the anterior part with disinfected hemp, catgut, or silk, or applying an elastic ligature, the cord is snipped off $\frac{1}{4}$ inch below the ligature. Other operators perforate the cord, ligature the anterior portion, and then divide the entire cord.

Lafosse recommended simple ligation of the spermatic artery. By stretching and flattening out the cord on the index finger of the left hand, and feeling carefully with the thumb the artery may be recognised as a stout pulsating vessel in the anterior portion of the cord. A needle is passed behind the artery, about $1\frac{1}{4}$ inches to 2 inches above the testicle, and ligation performed, after which the spermatic cord is divided $1\frac{1}{4}$ inches below.

6. In former times Lafosse recommended Simple Division of the Spermatic Cord. Experiments made by him, Barthélemy, Goubaux, Hering, and others showed that under certain circumstances this method is not followed by fatal bleeding, even in large animals. At the same time, there is absolutely no ground for suggesting that it is a safe procedure. In many cases severe bleeding occurred, and although not proving fatal, nevertheless greatly weakened the animals. One horse lost 27 pounds of blood. In carnivora this method of castration is not followed by severe bleeding, though even in their case it is not reliable.

7. Division of the Spermatic Cord by the Cautery is one of the oldest methods of castration, and even yet is frequently used in horses and bulls. It is undoubtedly, however, painful, and, as equally reliable and less painful methods are available, has been relinquished by many. A heavy hatchet-shaped iron, which will retain its heat for a considerable time, is used. The spermatic cord is exposed as above indicated, and a broad iron or wooden clam is applied immediately above the epididymis, serving both to fix the cord and guard neighbouring parts from the heat. The spermatic cord is divided about an inch below the clam, and the stump repeatedly touched with the back of the iron, until, on cautiously relaxing the

clam, bleeding is seen to have ceased. To prevent the iron adhering to the stump of the cord some operators apply a little oil before cauterising.

8. Castration with Clams.—On the Continent this method was until recently the most popular for horses, bulls, and old boars. It may be divided into two varieties:

(A) *Castration with exposure of the testicle.*
(B) *Castration without exposure of the testicle (the covered operation).*

(A) In the first method a long incision is made through the lower surface of the scrotum, parallel with the middle line, dividing the outer skin, tunica dartos, and external vaginal covering, exposing the testicle and spermatic cord. The cord, having been flattened out, is then

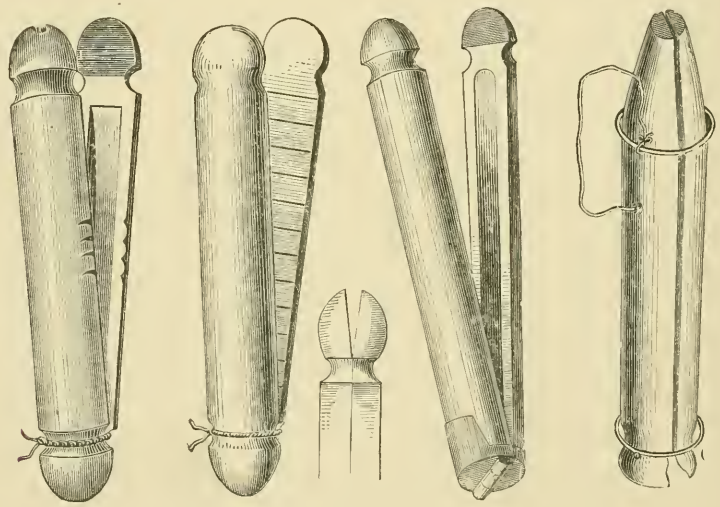


Fig. 238.—Wooden clams.

enclosed in a pair of clams, consisting of two pieces of wood about four to eight inches long, and $\frac{1}{2}$ inch to $\frac{3}{4}$ inch broad, united at one end by means of a cord or hinge. The open ends are brought together with special forceps and powerfully compressed, allowing a second cord, a small iron ring, or a leather cap to be applied for the purpose of fastening them together. After twenty-four hours the clams are removed, though they may be left in position for two or three days, or still longer.

The clams should be made of hard, tough, light wood, like birch, ash, or hickory. The edges should be well rounded to prevent injury of and bleeding from the plexus pampiniformis, which is

apt to occur in consequence of the sharp edges. The clams are either half round in section, or the flattened crushing surface is excavated, allowing greater pressure to be exerted on the narrower surfaces left. The latter form deserves preference. The central excavation is often filled with some caustic, like sulphate of copper, red precipitate, or sublimate and flour paste. The reason for using caustics was to ensure complete necrosis of the portions enclosed within the clams, but it is better to use a disinfectant, which prevents decomposition in the necrotic portion of the cord, and infection of the neighbourhood.

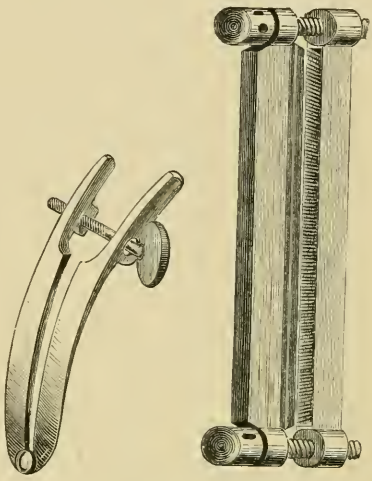


Fig. 239.—Iron clams.

Möller recommends a concentrated solution of sublimate in gum arabic mucilage, painted two or three times over the pressure surfaces of the clams. Schlammp first applies to the clams a strip of gauze, saturated with sublimate solution, which adheres firmly on drying and greatly facilitates removal of the clams after operation.

The furrow on the pressure surfaces of the clams was probably first used with the idea of preventing the clams slipping off, an object which, without doubt, it fulfils. It also facilitates the application of disinfectants, however, and increases the intensity of the pressure, inasmuch as it concentrates it on a narrower surface.

Various forceps and screws have been constructed for closing the clams, but the instrument most commonly used is shown in Fig. 240.

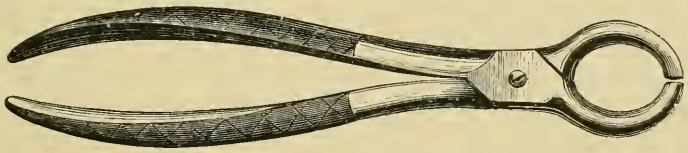


Fig. 240.—Forceps for closing wooden clams.

Should no reliable assistant be available for holding the forceps whilst the operator ties the clams, the forceps may be provided with a catch near the base, in which case they may also, in case of emergency, be used as "bull-dogs." The screw instrument (Fig. 241) permits the operator to dispense with assistants. Iron clams (Fig. 239) are

sometimes used; they are less liable to yield or bend, but in most cases are too heavy.

(B) In castration by the covered operation all the coverings of the testicle outside the tunica vaginalis reflexa (or tunica vaginalis scroti) are carefully divided, and afterwards stripped from the testis and cord as high as may be required. The clam is applied to the cord above the epididymis and over the external or parietal vaginal covering, and is fastened as above described. The testicle and lower end of the vaginal sheath are removed with scissors; the clams are left in position for twenty-four to forty-eight hours, and in cases of hernia it is advisable not to remove them until the third to fifth day after operation.

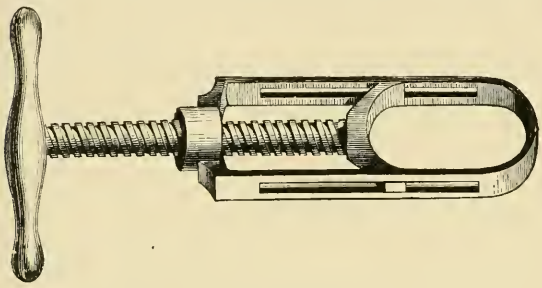


FIG. 241.—Screw instrument for closing wooden clams.

1. Castration of Stallions.

For reasons already given the second year of life is that usually selected for operation, as it appears the most generally suitable period, and the animal probably suffers less pain than it would at a later period. In this country, however, many animals are castrated during the first year. Stallions of any age can be castrated without danger, provided no disease of the organs of generation exist, and the ordinary rules of antisepsis are observed.

Before operation the scrotum is examined, to detect the existence of rupture, and note is taken of the strength of the spermatic cord, and width of the inguinal ring.

Foals are best kept without food on the morning of the day of castration; older, more excitable, and more powerful animals should have been kept on short diet for some days before, or have been regularly worked. Some authorities condemn restricting the diet of animals before operation, because it favours prolapse of omentum, or bowel, and castrate yearlings without any such preparation. Such points are probably of little importance, though it cannot be denied that the small bowel is less likely to pass the inner abdominal ring and the inguinal canal when full than when empty. Racehorses

should not be castrated when in training, as their muscular strength is so great that limbs may be broken during operation. In England, America, and France, horses are sometimes castrated in the standing position, though this is certainly not favourable to proper performance of the operation, as is conceded even by supporters of the method. It succeeds well enough in foals and quiet phlegmatic animals, which, however, can also be cast without much danger. Joyeux is believed to have been the first to castrate horses standing. The method was afterwards modified by the American castrator Miles, and more recently has been recommended by a number of operators in England, and by Salinier, Cagny, and others in France. Joyeux operated from the right, Miles from the left side, both with clams, the former by the covered, the latter by the exposed method.

Joyeux applies blinds and a twitch, and fastens the horse up short by means of a strong head collar. After placing hobbles on the hind feet, connected to a cord passing round the neck, the operator takes up his position facing the horse's right flank; with his left shoulder somewhat lowered and his left arm advanced he then grasps the scrotum and draws the testicles one by one downwards, the left hand gliding downwards along the course of the spermatic cord. Immediately the cord has been secured by the left hand, the layers of the scrotum are successively incised from in front backwards, care being taken to protect the left thumb. On dividing the outer skin and tunica dartos, the testicle descends, whereupon the operator separates these tissues from the processus vaginalis, until the assistant, who stands at the horse's left side, can slip a pair of clams from behind over the spermatic cord. This accomplished the operator grasps the forward end of the clams, applies the forceps or screw, and the assistant ties the clams. During the operation the forceps must be pressed towards the abdomen, and in a backward direction in order to prevent the spermatic cord being torn through. After snipping off the right testicle the left is removed in the same way.

Salinier operates by means of caustic clams, and first of all applies a ligature around the neck of the scrotum. Whilst the operator draws the testicles downwards the ligature is applied and tied by an assistant; the more tightly it is drawn the quieter does the horse remain during operation. Trasbot, whose practical experience is very great, altogether condemns castration in the standing position.

Miles castrates foals from the left side. He ties the animal up short with the right side against the wall, and thrusts a scaffold pole or similar piece of round wood against the animal's left thigh in order

to prevent it kicking the operator. The clams are applied over the uncovered spermatic cord and fastened with a leather ring, which is slipped over their conical end. This obviates the somewhat tiresome necessity for tying.

In England, castration in the standing position has recently been considerably practised. Griffith describes the operation as follows :— An assistant stands at the animal's left side, with his right shoulder against the animal's left. A second assistant holds and hands the necessary instruments.

The operator, who also stands on the animal's left side, slips his left hand along the animal's abdomen as far as the scrotum, grasps the right testicle, and draws it down to the bottom of the scrotum, which is immediately opened by an incision with the right hand from before backwards. He then discards the knife. The left hand at once grasps the protruding testicle and draws it backwards, whilst the right hand passes the open clam between the hind limbs and slips it from behind forwards over the spermatic cord. Thereupon the left hand seizes the free ends of the clam and presses them together. As soon as it has been ascertained by means of the right hand that only the spermatic cord, and not a portion of the scrotum is included in the clam, the latter is grasped with special forceps and firmly pressed together. The front ends are then secured with string and the testicle cut away. The left testicle is removed in a similar way. Griffith states having thus castrated 140 horses, varying in age from one to twelve years, during the course of one summer, without any noteworthy mishap.

Abroad it is usual to cast the horse for castration on the left side, the feet and hind quarters being somewhat higher than the body, though the dorsal position also has advocates. The right hind limb is released, drawn forward until the hoof is nearly in contact with the animal's chest and the whole limb is somewhat abducted, and is then resecured. It must not, however, be drawn too far forwards (the furthest allowable point is the elbow of the right foreleg) ; on the other hand, should it not be drawn sufficiently far the operator may be injured by the point of the hock. The liberated limb should not be fastened unyieldingly, as otherwise the animal may make violent extension movements, the resistance to which may cause fracture. It is preferable to pass a piece of webbing around the fetlock and hoof, and fix the limb in a position of plantar flexion.

The dorsal position has the advantage that prolapse of bowel is

less likely to occur, but it necessitates more assistants; the side position is equally useful, provided a careful examination be made before operation.

Nervous thoroughbred animals should be anæsthetised to prevent accidents like broken back, which are sometimes caused by the violent struggling occasioned when the clams are compressed. Since adopting this precaution Möller has had no cases of broken back. Röder claims to have rendered even the application of clams painless by injecting cocaine into the scrotal subcutis.

(A) Castration of the Stallion by the Application of Clams.—Although this method receives first notice it has of late years been largely replaced by torsion of the spermatic cord, an operation which has found increasing acceptance and on the whole seems preferable.

(*a*) *Castration with exposure of the testicle.* The normal condition of the spermatic cord and outer abdominal ring having first been ascertained by palpation, an assistant cleanses the scrotum and surrounding parts with soap and water, rinses them with sublimate solution, and afterwards carefully mops up all superfluous moisture with a clean cloth or tampon of cotton wool, giving particular attention to the fold of skin between the inside of the thigh and the scrotum, so that no fluid may be left to find its way into the wound during operation. Kneeling behind the horse the operator first grasps the left testicle by passing the left hand from before backwards around the left spermatic cord. In carrying this out, the open right hand is thrust between the scrotum and the surface of the left thigh, whilst the left hand endeavours to grasp the spermatic cord from in front, and to thrust the testicle towards the base of the scrotum. The correct position of the testicle is known by the fact that the scrotal raphe lies parallel to the testicle, on its inner side. In the case of young animals it facilitates the task of securing the testicles if a ligature be passed around the scrotum before the animal is cast. The skin

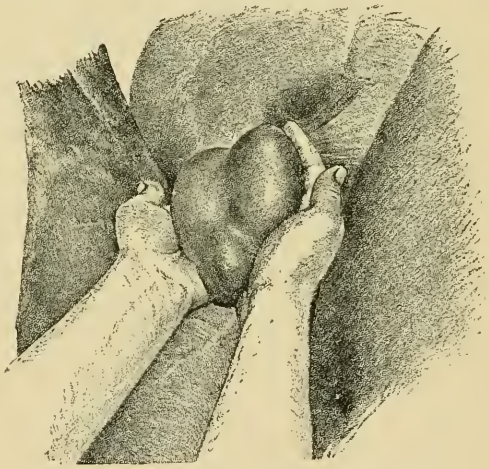


Fig. 242.

covering the testicle is next rendered tense and a long incision made through it, parallel to and about an inch from the scrotal raphe, by means of a sharp convex knife. This incision divides the outer skin, tunica dartos, and other loose coverings, and may extend into the substance of the testicle itself without detriment. Some operators first incise only the skin and tunica dartos, opening the sac of the tunica vaginalis with a second incision. Nothing is gained by this method. It is, however, of great importance to make the incision in all three coats as large as possible, in order to provide for effective drainage at a later stage. This is particularly true in the case of the sac of the tunica vaginalis. The testicle will often appear even if the scrotum be insufficiently opened, but such a method is to be avoided. Pflug and Brücher recommend first incising the tunica vaginalis reflexa in front and afterwards behind, leaving a portion in the middle undivided, and afterwards uniting the two incisions. This ensures a long opening, which, if necessary, may be extended with scissors.

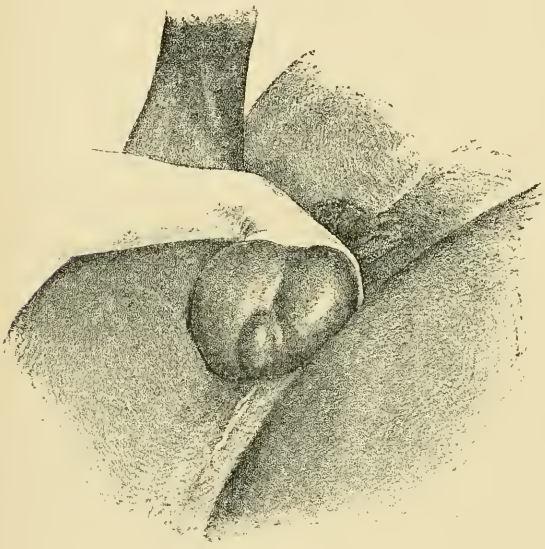


Fig. 243.

When performing castration aseptically, however, the exit should be small, as healing is thereby favoured.

The operator now discards the knife, grasps and draws forward the exposed testicle with the right hand, whilst with the left he thrusts back the scrotum and other loose envelopes, so as to expose the cord sufficiently to permit of the application of clams. More extensive exposure than this should be avoided, as it only favours infection. At this moment, as a rule, animals endeavour to retract the testicle by means of the cremaster. One therefore waits a few moments, exercising strong but steady traction on the testicle, and drawing it forward sufficiently for the clams to be applied above the epididymis. The necessary movements should be made slowly, and excessive tension or dragging on the cord should be avoided. Should contrac-

tion of the cremaster muscle be long continued, the animal may be struck smartly with the open hand, but as a rule the testicle can be drawn forward without difficulty as soon as the first struggles have subsided.

The operator then grasps a suitable clam with the left hand and passes it from in front backwards over the spermatic cord (which should be flattened out as much as possible), giving the clam such a direction that it will hang horizontally when the animal is standing, and will at least be above the epididymis. When the cord is exceptionally long the clam should be applied proportionally higher; it may, in fact, be placed as high as possible, without exercising undue tension on the cord.

The posterior (open) ends of the clam having been compressed with the fingers of the left hand so that it firmly grasps the spermatic cord, the testicle may be released and, the hold on the clam having been transferred from the left to the right hand, the screw or forceps may be applied. During the closure of the clam by either of these instruments the animal usually becomes restless, and struggles unless previously anæsthetised. To prevent injury or tearing of the spermatic cord the twitch may be shaken whilst the forceps or screw is being closed, and the clam itself can be pressed against the animal's abdomen. The operator should have made sure while applying the clam that no part of the scrotum was included in it, but in any case at this stage of the operation he should again examine the parts before finally securing the clam with cord. Care is also required to prevent the spermatic cord slipping beyond the crushing surface of the clam. Provided all is found satisfactory, the clam is secured by a surgical knot, drawn very tightly. The spermatic cord is then divided with scissors, one half to one inch below the clam. Should the spermatic cord be very short a fragment of the epididymis may be left

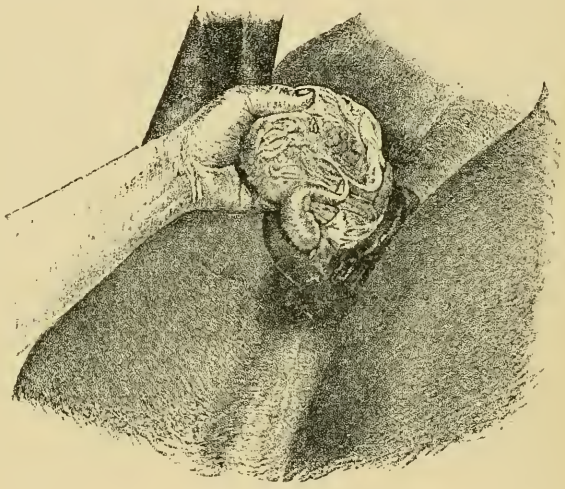


FIG. 244.

adherent to it. Formerly it was usual to incise this with scissors at two or three points, but the practice is irrational.

The right testicle is then removed in a similar way, care being taken not to displace the clam already applied or to throw any strain on the left spermatic cord. The wound and inner surface of the left thigh are then carefully cleansed, the clams gently arranged one above the other, with their posterior ends crossing, the sheath is drawn somewhat forward, the exposed stumps of the spermatic cords are powdered with iodoform, and the horse is allowed to rise.

Formerly it was usual to divide the posterior non-vascular portion of the cord before applying the clam. The method is not commendable, because the clam is then only suspended by the anterior portion of the cord, which readily yields, allowing the clam to descend. In the method described the clam, on the contrary, is suspended by the cremaster and the vascular portion of the cord.

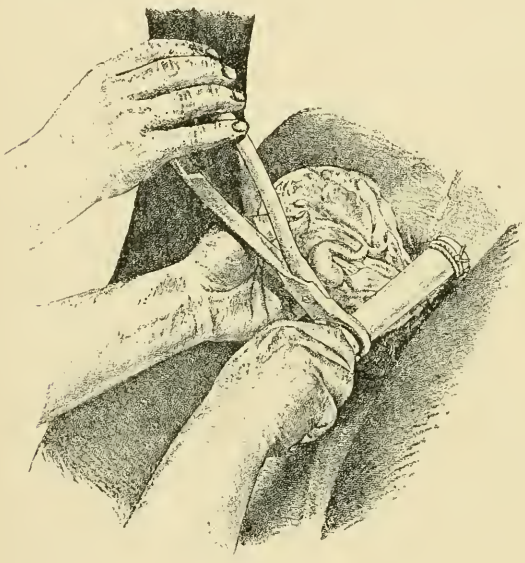


Fig. 245.

The horse is placed in a quiet well-ventilated stall, is tied up short in order to prevent its lying down, and receives light, easily digested food. Its tail, which should previously have been plaited, is now fastened to one side by attachment to the surcingle or to the shank of a web halter passed round the neck. Most animals will at once take hay, which should be given, as feeding distracts attention from the seat of operation, and prevents restlessness. Should the animal strain greatly, it should be watched, and, if restless, should be checked by the attendant calling to it or lightly touching it with the whip.

When the spermatic cords prove exceptionally long, the clams may be applied higher. As a general principle, they should be placed as high as possible, without exercising any violent strain on the cord. Under no circumstances should the clams after castration hang so low as to leave a portion of the spermatic cord visible above them, as in-

fection of the parts is thus favoured, leading at a later stage to complications like scirrhous cord, or to severe inflammatory processes. This is more likely to occur in weakly animals, for which reason the clams selected should be very light, and should be placed as high as conveniently possible; they may also be supported by two or three sutures passed through the edges of the scrotal wound. Regarding removal of the clams we shall later give directions.

(*b*) For castration without exposure of the testicle (the covered operation) the animals are prepared and cast in precisely the same fashion as before described. The operator first grasps the left (lower) testicle or spermatic cord, taking particular care that the scrotum is tightly stretched over the testicle. The incision is at the same point, but is made very long, dividing, however, only the skin and tunica dartos, and exposing the loose connective tissue, which lies between the latter and the common vaginal sheath.* The edges of the wound open widely when the incision reaches this layer. By light cautious strokes with the knife this tissue is divided in the longitudinal axis of the testicle until the tunica vaginalis reflexa, readily recognised by its greyish-blue colour, is exposed. The knife is then discarded, the operator grasps the testicle with the right hand and with the left endeavours to free the tunica dartos, etc., from the tunica vaginalis reflexa sufficiently far for a clam to be applied to the spermatic cord above the epididymis. The connective tissue should, if possible, be entirely stripped away from the exposed portion of the tunica vaginalis, not only to facilitate application of the clam, but to prevent infectious sequelæ. Before the clam is applied the operator must once more convince himself by manipulation of the common vaginal sheath that only the spermatic cord is present. The clam, which must be somewhat larger than that used in the last operation, is applied as before described, care being taken that it includes the whole of the spermatic cord. After carefully tying the clam, the testicle and base of the processus vaginalis are removed with scissors. The second testicle is removed in a similar way, the parts are cleansed, the clams arranged as before described, and the sheath drawn forwards. The horse is then allowed to rise. The after-treatment is as above described.

A modification of this method recently introduced by Degive

* "Common vaginal sheath" and "processus vaginalis communis" are surgical terms authorised by the Berne Anatomical Congress to describe the three adherent layers described in Professor McFadyean's 'Anatomy' as (1) spermatic fascia; (2) cremasteric fascia; and (3) infundibuliform fascia. See also note on "Anatomy" at the commencement of this chapter.

consists in opening the tunica vaginalis and exposing the testicle, but when applying the clams, grasping and drawing down the edges of the vaginal sheath so as to include them in the clams. The vaginal sheath having been exposed as above described, the testicle is grasped with the right hand and drawn slightly forwards, in consequence of which the outer skin and tunica dartos retire, and a portion of the vaginal sheath is exposed. A fresh hold of the spermatic cord is then taken with the left hand, whilst with the right the base of the tunica vaginalis is opened sufficiently to allow the testicle to be extruded. The anterior and posterior portions of the base of the sac thus come to form blind sacs. Into the posterior of these the operator at once thrusts the index finger of the left hand, into the anterior the thumb of the right, and drawing the vaginal sheath forward, together with the spermatic cord, enables an assistant to pass a clam from in front backwards just above the epididymis, embracing both the vaginal sheath and the spermatic cord. The ends of the clam are pressed into contact and fastened with a surgical knot, and the spermatic cord is divided about an inch below the clam.

This represents a middle course between the operations of castration with and without exposure of the testicle, being, in fact, castration with exposed testicle, but with covered spermatic cord. It requires some practice, because the vaginal sheath is very apt to elude the operator, and it is difficult to again grasp and draw it forward. Attempts were made by applying a pair of forceps to overcome this difficulty and facilitate operation, but they necessitated the presence of a skilled assistant. Moreover, the only advantage this method has over the covered operation is, that when the common vaginal sheath is short, it is less likely to be overstretched. It is, however, useful when one has to deal with scrotal hernia which has only been discovered at the moment of opening the tunica vaginalis. In old stallions in which castration by the covered operation, or by Degive's method just described, is particularly necessary, the processus vaginalis is usually so long that clams may easily be applied.

The removal of the clams is of scarcely less importance than their application. In castration with exposure of the testicle the clams are usually removed after twenty-four hours, in many parts even earlier; in young animals especially they may be removed without danger within five to six hours after operation. In Sweden and Denmark, Tidholm's method is commonly used for castrating horses. Clams are applied to the spermatic cords, which are firmly compressed. The clams, however, are almost immediately removed, a ligature is applied, and the testicles removed. In castration by the covered method, the

clams are usually left in position for forty-eight hours, though Degive recommends leaving them three to five days. Möller also approves the longer period, and finds that inflammatory symptoms are then less marked, and fever rarer than when the clams are removed forty-eight hours after operation. This is explained partly by the fact that after the clams have been several days in position the necrotic stump of the spermatic cord is not so liable to be retracted upwards, carrying septic material into the upper portion of the sac of the tunica vaginalis. It must also be remembered that after a few days the edges of the wound become infiltrated with plastic material, and are therefore less likely to be infected than twenty-four hours after operation. At the time of removing the clams, however, the greatest care cannot prevent circumstances arising favourable to the absorption of wound discharges. It is common experience that inflammatory swelling or fever first appears on removal of the clams. Provided their position be satisfactory the clams may be left on for four or five days; otherwise, and especially if they are so pendent that the cord shows above, they must be removed as soon as possible. The operation is carried out in the following way :

A bridle is applied and held by a capable assistant, and one of the animal's fore feet is lifted. It is best first to attempt removal without using the twitch; should the attempt fail it can be applied. Having provided himself with a strong, clean pocket-knife, the operator places himself at the horse's left side, the left hand resting on the animal's loins, and, using curved scissors, endeavours first of all to clip away the portion of the spermatic cord hanging below the clams. The thumb of the right hand is then placed against the front of the clam, the knife is slipped between the back ends and the string uniting them is divided. At the same time the knife is rotated in the hand, forcing the two portions of the clam apart. Discarding the knife for a moment the operator seizes the free ends of the clam with both hands, and slowly opens them as far as possible. The spermatic cord is then usually found to be adherent to one side of the clams. Should not the artery have become thrombosed a bluish-red line appears in the parchment-like remnant of the cord, and extends towards the cut margin until finally a few drops of blood fall. In such case a silk thread must be passed round the vessel at the margin between the healthy and the crushed portions of the cord by means of a sharply curved needle, drawn tight and knotted. If no bleeding occur the cord is cautiously separated by sliding the thumb from in front backwards along the depression in the centre of the clam. The operator then throws the clams to one side, rinses his hands in sublimate solution

or other disinfecting fluid, and endeavours to free the spermatic cord from any adhesion with the scrotum by passing the index finger around the stump of the cord. After castration with exposure of the testicle, the finger can be passed around the spermatic cord, breaking down any adhesions between it and the common vaginal sheath. If necessary the operator grasps the edges of the wound and draws them downwards. In any case the spermatic cord must be returned into the sac of the tunica vaginalis or into the scrotum. The escape of considerable quantities of discharge is a favourable symptom, showing that the adhesions which favoured retention are broken down.

After removing the second clam in a similar way a strong stream of clean cold water or sublimate solution should be directed on the scrotum; it has the double effect of partially cleansing the wound and—much more important—of causing retraction of the spermatic cord. Vicious horses occasionally require to be cast for the above manipulation.

After removal of the clams the horse should be exercised daily for half an hour or longer in a place free of dust; in the country full-grown horses are at once put to light work. Experience has shown that long rest in the stable is disadvantageous. The good effects of movement and exercise are largely due to the fact that they favour escape of discharge. For a similar reason it is important to make the incision through the scrotum as large and dependent as possible. The extensive swellings which sometimes follow castration are almost exclusively due to want of cleanliness in operation or to retention of wound discharges.

No special treatment of castration wounds is necessary. The wound and neighbourhood should be cleansed daily with a clean sponge and boiled water until suppuration ceases. When high fever or severe swelling occurs, the wound should be opened with the disinfected hand, and any irritant discharge allowed to escape, after which the parts should be freely washed out with a disinfectant fluid.

In the horse castration with clams is still widely adopted on the Continent. British operators, on the other hand, seem to be rapidly relinquishing it. In two-year-old horses, bad results are seldom seen, provided the necessary care and cleanliness are observed. The greatest danger results from using dirty instruments and clams, especially if soiled with virulent infective material. Practitioners should exercise scrupulous care in this respect, and should carefully disinfect all instruments used on animals suffering from septic diseases. New clams should be used on each occasion.

In castrating foals the tunica vaginalis reflexa is always opened and the testicle exposed unless signs of hernia exist. In older stallions, especially when the outer abdominal ring is of abnormal size, the covered method, or Degive's operation (in which the spermatic cord is not exposed), is preferable, as it prevents prolapse of the bowel. Should the common vaginal sheath appear fairly long, the covered method may be employed. Where, however, it is little developed, the application of clams might cause dragging and severe pain, in which case Degive's method deserves preference.

Castration with clams has the drawback of necessitating a second, or even a third, professional visit. The precautions needed in removing clams are too important to be entrusted to laymen; rapid healing of the wound and avoidance of later complications can only be assured by the operator's personal attention.

(B) Division of the Spermatic Cord with the Actual Cautery.—A second method, sometimes used in the horse, consists in dividing the spermatic cord with the actual cautery. It has already been described, and has the advantages over castration with clams that it is aseptic, and that operation is at once complete. Provided proper care be taken, secondary bleeding is rare, and the local reaction, evinced by swelling, etc., is seldom more marked than after other methods. Care must be taken, however, to make the incision in the scrotum and tunica vaginalis reflexa sufficiently large to ensure free drainage.

(C) Torsion of the Spermatic Cord if carefully performed is also a reliable method, and has the great advantage of rendering a second visit unnecessary. It also seems less painful than castration with clams, which, even if skilfully carried out, must cause a certain strain of the spermatic cord. Moreover, healing is more rapid after torsion. Sloughing of the portion of the cord included in the clams must necessarily take a very considerable time. In torsion such delay is avoided, because the stump of the spermatic cord seldom becomes necrotic. Severe swelling, so marked after castration with clams, is therefore relatively uncommon, and scirrhous cord is a rare sequel.

The chief and practically the only objection to this method consists in the danger of secondary hæmorrhage. By using proper forceps, and operating carefully, bleeding can, however, be reduced to a minimum, even in the case of old horses. Nevertheless the owner's attention should be drawn to the fact that slight bleeding may occur, though it is not of importance. Möller used formerly to check bleeding after this operation by introducing a mass of sterilised tow into each of the scrotal cavities, and securing them with a couple of sutures,

but this appears bad surgery, and he has since discarded the application as unnecessary. It may, however, be utilised in case of need. The owner can readily remove the tow at a later period. Möller and many others recommend this method for castrating stallions, and during the past few years it has made numerous converts in Germany.

(D) Castration with the Écraseur.—In America and England the écraseur has been much used for castrating stallions. After exposing the testicle and spermatic cord the chain or wire of the écraseur is passed over the testicle and slowly drawn tight, dividing the cord just above the epididymis. The method has found acceptance at the hands of many practical men, though it seems to possess no particular advantage over carefully performed torsion.

(E) Ligation of the Spermatic Cord cannot be recommended for horses. Its disadvantage consists in the fact that the ligature material remains in the wound, keeping up chronic inflammation, and frequently leading to the formation of scirrhous cord. The use of catgut does not overcome this drawback because catgut is not absorbed from the stump of the spermatic cord, as from an aseptic granulation surface; experiment has shown that absorption requires at least one or two weeks. Moreover ligation of the spermatic cord is not so easy as might be imagined. Even when the ligature seems quite tight it is apt to work loose, on account of the action of the elastic tissues of the cord on the knots. Serious bleeding may thus be produced. Should the operator decide on ligaturing the cord, however, two methods are open to him. In the first the middle of the spermatic cord is transfixed by means of the finger, and the anterior and posterior portions are ligatured separately, care being taken that the anterior ligature is drawn particularly tight. In the second the entire cord is included in one ligature of sterilised catgut or silk. Some operators leave one end of the ligature sufficiently long to protrude beyond the wound, so that in a week after castration it may be removed, but this is unnecessary if antisepsis be observed. Again, the elastic ligature can be selected. Möller prefers catgut, because the elastic ligature acts slowly, and must therefore remain a considerable time in position. The most surgical method is ligation of the spermatic artery in continuity, and when carefully performed with aseptic precautions is quite safe.

Finally, it should be said that in castration less depends on the method than on the way it is practised. As the method most commonly used is usually best carried out, it results that many practitioners after a short trial of a new method, return to their older

procedure. Handiness and cleanliness exercise a marked influence on the success of operation. As regards cleanliness, one can never be too thorough, and although complete asepsis may not be secured, cleanliness, nevertheless, remains an important factor in ensuring success.

(F) ASEPTIC CASTRATION.—As was to be expected, soon after the theory of antisepsis became popular, experiments were made to ensure castration wounds healing by primary intention. Bayer first approached this problem in 1881, and was followed at a later date by Frick. Bayer had four successful results among fifteen horses operated upon. At that time he simply divided the cord and ligatured bleeding vessels, but frequently had secondary bleeding owing to the vessels escaping from the ligatures. He then resorted to simple ligation of the entire cord. Here also he had healing by first intention, but the horse was often compelled to lie down soon after operation on account of enormous swelling of the scrotum. In every instance he found that the ligature had slipped off. In one instance he noted the accident occurring. At every pulsation of the spermatic artery the ligature yielded, at first almost imperceptibly, afterwards at a faster rate. When the ligature was held with the finger the cord was drawn out of the loop. For this reason he now transfixes the cord and ligates it in two parts. Frick had seven successes among twelve cases. Guttman castrated two horses, two boars, two dogs, and a goat with antiseptic precautions, in each case obtaining healing by primary intention. Plósz was equally successful with six stallions.

One must not forget, however, that observance of the necessary principles of asepsis is much more difficult in private practice than in clinical institutions. Möller operated several times, but with varying results. The animals should be prepared, cast, and anæsthetised as above described. The necessary arrangements having been made, and the hands, instruments, and ligatures sterilised, the first step consists in thoroughly disinfecting the field of operation. The scrotum and its surroundings are carefully washed with soap and water, rubbed with alcohol, and rinsed with sublimate or other disinfecting solution. The upper hind limb and the hobbles restraining it should be moistened with a wet sponge, to prevent hairs falling on the operation wound. The other precautions are similar to those suggested in connection with antiseptic operations.

The operator first grasps the right testicle, presses it towards the base of the scrotum, incises the tunica dartos and tunica vaginalis, though not to the same extent as previously indicated, and allows the testicle to protrude. Having secured this, he ligatures the spermatic cord with two or three ligatures, according to its thickness.

To facilitate operation, compression forceps are applied to the cord, and the ligatures applied below them, catgut or silk being used. The ligature is placed above the epididymis, and the spermatic cord divided half an inch below the point of ligation. Any blood that may have escaped is removed with sterilised pledgets of cotton wool, the wound in the scrotum closed with button sutures, the tunica vaginalis, if possible, being included, though this is often difficult. The sutures should be inserted deeply, so as to bring the subcutis in contact over a considerable area. After the left testicle has been removed in a similar way, the surface is rinsed with a disinfecting fluid, powdered with iodoform or iodoform and tannin, and covered with a thin layer of wadding, which adheres to the skin by means of the tannin, and remains as a protection after the horse rises.

Bayer has also removed both testicles through a single opening. After operation the horse was allowed to rise, and the scrotum covered with iodoform gauze, a mass of cotton wool applied below it, and the whole secured by a suspensory bandage consisting of a triangular piece of linen, to the corners of which tapes were attached. The narrower end fitted between the hind legs; the tape from this was passed alongside the tail, over the croup, and fastened to a roller strapped round the chest. The other tapes were passed over the back and knotted together. The tail was suitably secured.

The difficulties in obtaining asepsis are less apparent during operation than afterwards, inasmuch as a bandage is difficult to apply, and a really secure protection against infection can scarcely be devised.

The right (upper) testicle should first be removed, so that when operating on the second testicle, the first operation wound may not be soiled. Irrigation of the wounds is usually neither necessary nor desirable, as it retards healing. Should, however, the wound have been soiled, it should be washed out with a free stream of antiseptic fluid.

Aseptic castration has not yet been seriously practised, and is scarcely likely to become common on account of its great inherent difficulties. Whilst ordinary castration, with exposure of the testicle, can be performed in from four to ten minutes, aseptic castration demands from half to three quarters of an hour. The preparation is troublesome, and anæsthesia becomes necessary. Moreover, it offers no great advantages. Castration by ordinary methods is seldom followed by bad results. Nielsen castrated forty-one stallions and eleven boars by torsion, without using sutures, and only saw swelling and suppuration in two of the stallions, a result which bears favourable

comparison with those afforded by aseptic castration, and is worthy of serious consideration in choosing a method. The troublesome and tedious preparation required by the aseptic method is in no way commensurate with the advantage to be gained. This, however, seems less serious than the fact that one can never depend on attaining absolute asepsis, the operation wounds being necessarily of such a character as to heal with considerable difficulty, the incisions being too small to permit of free drainage, and fluids, etc., being apt to be retained ; severe local inflammation and serious feverish symptoms are then very liable to occur. The difficulties inherent to asepsis result partly from external circumstances, such as the difficulty of applying a dressing, which many animals will absolutely not endure, and partly to the fact that even with the greatest care bleeding cannot always be prevented. This usually sets in after the animal has risen, and originates in the veins of the common vaginal sheath. Blood is poured into the scrotum, and endangers aseptic healing. In cryptorchids, in which this sheath is absent, antisepsis is therefore more easily attained than in ordinary stallions, as is shown by the experience of Bayer, Guttmann, Plósz, and others. Until these difficulties can be overcome aseptic castration will remain a strictly academic operation.

Castration of the ass calls for no particular modifications. Weber states having had fatal bleeding after torsion of the spermatic cord, a result, he believes, due to the fact that in these animals the cord is unusually fragile, and is apt to tear.

2. Castration of Male Ruminants.

Although the same principles apply to the castration of ruminants as to that of horses, yet variations in anatomical arrangement of the organs of generation and in external circumstances necessitate numerous modifications. Apart from goats, which appear particularly sensitive to ordinary methods of castration, ruminants seem to bear operation better than horses. Bull calves may be castrated by torsion or ligation, the elastic ligature being used if desired. Older animals are usually castrated with clams by the covered method. The application of clams or of a ligature to the entire scrotum is seldom practised, except by laymen.

Bulls bear castration best during the first few months of life, an age at which the operation is also most easily performed. Should the animals be intended for draught purposes, however, castration is commonly postponed until the second year, as the neck and shoulders are then better developed.

The operation is usually performed in the standing position; only old vicious bulls are cast. For operation in the standing position the animal is tied up as short and as strongly as possible, a bull holder is applied, and a fore foot lifted. The hind feet may, if necessary, be secured by a rope passed around the neck, though this is seldom necessary. One or two strong assistants may be placed on either side of the quarters to prevent the animal moving laterally.

The operator stands behind the animal, grasping the scrotum with the left hand. When castrating with clams, he incises the base of the scrotum and the tunica vaginalis, applies the clams as in the horse, and removes the testicle. The clams are left in position for twenty-four hours, or even longer, but animals may be allowed to lie down before this.

Division of the spermatic cord with the actual cautery is performed as in the horse. Young bulls may be castrated by twisting or scraping the cord in the above-described manner.

"Bistournage," *i. e.* torsion of the spermatic cord within the scrotum, is also worthy of notice. When successful it is followed by atrophy of the testicle.

It has chiefly been practised on bulls, rams, and goats, but in a few cases also on stallions.

The operation may be divided into four stages. The operator first endeavours to loosen the connection between the dartos and the underlying tunics (common vaginal sheath) by forcibly thrusting the testicles upwards and downwards. For this purpose he first grasps the scrotum above the testicles with both hands and rapidly thrusts the testicles towards the base of the scrotum, where he fixes them by means of the right hand. With the left hand he then grasps the lower part of the scrotum and pulls it vigorously to and fro. Next, he takes hold of the scrotum with the right hand immediately above the left, and in this way pushes the testicles towards the inguinal canal. The testicles are again pulled backwards and the above-described manipulation repeated until the testicles can be freely moved in all directions (Fig. 246). During this manipulation the rupture of the connection between the skin and underlying tunics can be distinctly felt. In the second stage one testicle is forced to the base of the scrotum and fixed in this position with the fingers of the left hand, which grasp the spermatic cord close above the gland (Fig. 247). The lowest part of the scrotum is held with the right hand, which next co-operates with the left, impressing the upper end of the testicle downwards and forwards and the lower end upwards and backwards, thus rotating the testicle at an acute angle to the spermatic cord. The testicle is prevented from returning to its normal position by the left hand grasping the scrotum

and spermatic cord just above the half-rotated testicle. The hands now occupy their original position and the manipulation is repeated.

Third stage (Fig. 248). The right hand grasps the testicle and turns it from left to right, the left hand at the same time pressing the spermatic cord from right to left. This produces a half-turn in the spermatic cord; the part played by the hands is now reversed, the left hand pushes the testicle from left to right, the left hand thrusting the spermatic cord from right to left, making the twist complete. This manipulation is repeated from two to four or five times, depending on the length of the spermatic cord.

Fourth stage. The above operations having been performed on

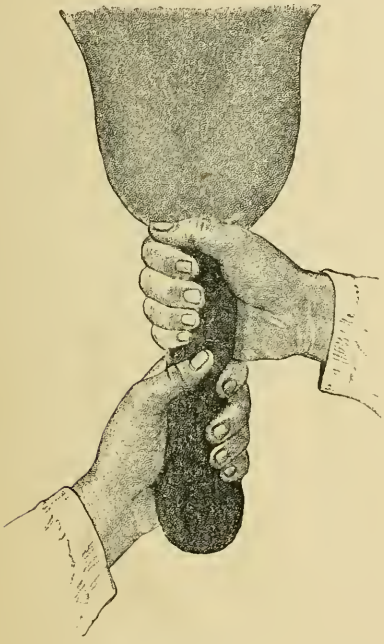


Fig. 246.

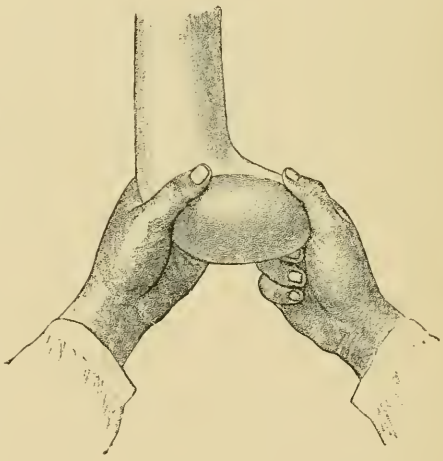


Fig. 247.

each of the testicles, the lower part of the scrotum is grasped with both hands and the testicles pushed as far towards the inguinal canal as possible. Both should rest at the same height. Whilst the empty lower part of the scrotum is held fast with the left hand just below the testicles, the right hand passes a loop of cord (one end of which the operator holds in his teeth) three or four times around the scrotum, between the left hand and the testicles, so that the latter cannot slip downwards, and ties the ends together (Fig. 249). The loop, however, must not be drawn so tight as to stop circulation in the lower part of the scrotum; it is only required to keep the testicles in the position

given them until the exudation and swelling which follow the above manipulation can fix the spermatic cords in place, and thus prevent the cords untwisting. The loop is removed in twenty-four to forty-eight hours.

When the union between the dartos and the common vaginal sheath is very firm, operation proves much more difficult, or may be impossible. In such case it may again be attempted on the succeeding day, the exudation between the layers of the scrotum produced by the first manipulation often rendering subsequent handling much easier.

The animals show great pain after operation, become very restless, and often throw themselves down. Some show peculiar spasmodic contraction of the masseter muscles and of the muscles of the neck.

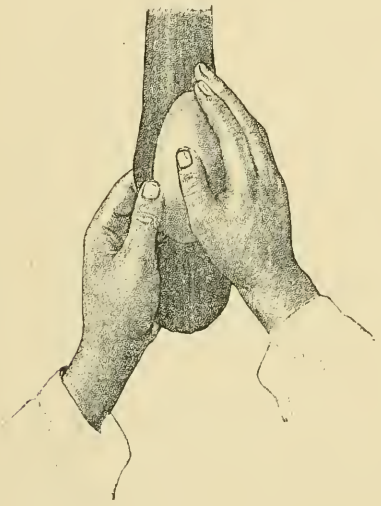


FIG. 248.

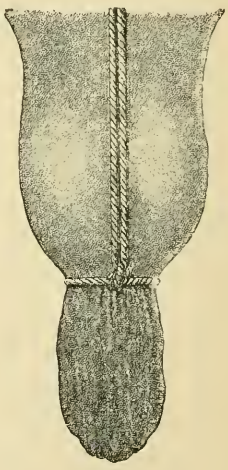


FIG. 249.

The legs become rigid, and the animals exhibit symptoms recalling those of strychnine poisoning. These appearances, however, only last from two to four hours, after which the animals appear to have perfectly recovered. The scrotum then begins to swell and continues to increase in size. In the upper part of the swelling the testicles can be felt; the lower part consists only of the infiltrated and swollen scrotum. The swelling having attained its height remains stationary for some days, and then gradually disappears; the testicles slowly undergo atrophy for a period of several months.

Occasionally the testicles rotate after removal of the loop of cord, and the operation proves futile. Failure is shown by the spermatic cord again becoming soft; when the operation has been successful the

cord feels hard and distended. In such case operation must be repeated, but is then usually rendered much more difficult by adhesions having occurred between the layers of the scrotum. These adhesions become firmer and more intimate as time passes; in the course of even a few days a repetition of the process proves impossible, and castration must be performed in some other way.

In South Germany, and especially in Bavaria, bulls are very often castrated with the "caustic ligature," that is, a strong cord saturated with a mixture of equal parts of sublimate and gum arabic dissolved in twice their volume of water. Many experienced operators warmly recommend this method, though some have noticed after-symptoms of mercurial poisoning, especially in young animals. An extensive eruption, which may persist for a month or six weeks, occurs over the whole body, and is accompanied by local depilation. This has been attributed to excess of sublimate in the ligature, and some operators therefore recommend saturating the cord with a solution of three parts of sublimate in thirty parts of collodion. The caustic ligature has the advantage of more rapidly dividing the spermatic cord, and therefore of separating sooner, whilst the sublimate exercises a disinfecting action both on the cord itself and on the wound. Some practitioners, however, have noted severe swelling after this operation. Eckmayer ligatures the exposed spermatic cord with carbolised silk, and removes the testicle half an inch below the ligature. He operated thus on more than 100 calves without any bad result. Günther recommends the use of the elastic ligature for bulls.

Another method of castration has been recommended. After opening the scrotum the spermatic cord is perforated between the vascular and non-vascular portions with a knife, and the index finger of the left hand is inserted in the slit so produced. The testicle being removed with the knife, the stump of the cord is passed through the slit, and tied in a knot. Should bleeding not immediately stop a second or third knot may be tied. Some operators first divide all the non-vascular portions of the cord with the knife, then, after grasping the blood-vessels firmly with the finger and thumb or with forceps, divide these low down near the testicle. One or more knots are then tied as high as possible on the vascular cord and drawn tight. As soon as the operator is satisfied that bleeding is no longer to be feared the free end of the vascular cord is snipped away three quarters of an inch below the knot or knots; the latter are returned into the sac of the tunica vaginalis and thrust as high up as the fingers can reach. The method is particularly recommended for old

bulls, and is carried out in the following manner:—The animal is placed with its right side against the wall, and its left hind foot is fixed by means of a cord passed around the neck. An assistant standing opposite the hind quarters holds the limb by the Achilles tendon with his right hand, and draws it outwards. As in calves the spermatic cord is not fully developed, the knot is sometimes difficult to tie. The greatest cleanliness must be observed.

Wehrhahn has shown that bulls may be castrated aseptically, though only at the cost of much time and care.

Sheep are best castrated between the fourth and sixth weeks. The animal is laid on a table (lambs are held by the legs), the limbs being grasped by an assistant or tied together; old rams should be placed on the back, and held by a couple of strong men. In lambs, scraping or torsion is the best method. Old rams may also be castrated by torsion, provided sufficient care be taken, though ligation is also successful. Clams are very seldom used in sheep. The scrotum is either opened as in the horse, or its base is cut off, a method which ensures free drainage.

Goats are best castrated by subcutaneous ligation of the spermatic cord or by means of the elastic ligature, as before mentioned.

3. Castration of Swine.

Swine are usually castrated during the first few weeks or months of life, though not infrequently one is required to operate on old boars. No particular danger attends operation on these animals provided that previous to casting the scrotum and inguinal canal be examined for inguinal hernia, which in them occurs with some frequency. The pig being laid on its back on a table and held by one or two assistants, the operator presses the testicles towards the base of the scrotum with the left hand. He then incises the covering of the testicles, parallel to the scrotal raphe, and about $\frac{3}{8}$ to $\frac{1}{2}$ inch distant from it, allowing the testicles to protrude. Although in young animals simple division of the spermatic cord with scissors is not always attended with danger, yet torsion is preferable, and is carried out, after dividing the posterior portion of the cord, by passing the index finger through the spermatic cord, just above the epididymis, whilst the cord is grasped a short distance above the epididymis with the thumb and index finger of the left hand. The index finger of the right hand is then rotated, and the cord twisted until the testicle falls away. Another method consists in dividing the posterior part of the cord with a knife, laying the remaining portion on the index finger of the left hand, and scraping it with a blunt knife until completely divided.

Older boars are best castrated with clams or ligature. The operation can be performed in the standing position, though the animal's head must be firmly secured, and its hind limbs fixed by passing a couple of poles between the legs, so that it can neither lie down nor move to either side. The operation is, however, most conveniently performed with the animal lying on one side. No particular after-treatment is necessary, but the animal should be placed in a separate, cool, clean stall. The clams can be removed after twenty-four hours, though they are generally left in position until they spontaneously fall away. Grün recommends castrating boars by ligating the spermatic cord with a dry, thin catgut ligature.

4. Castration of Cats and Dogs.

Dogs bear castration well at all ages. The animal is placed on its back, and the processus vaginalis opened as above described. In young animals the spermatic cord may be simply snipped through with scissors or scraped with a knife. The point of division is just above the epididymis. In older animals ligation is preferable, as bleeding may be prolonged by the animal licking the parts. Cats are similarly treated. Some operators fix the animal by enveloping the fore-part in a sack; an assistant holds the hind legs. Scraping, twisting, or ligation may be used.

5. Castration of Birds

is on the whole simple, though the operation requires some practice. The cock is the bird most often castrated; the bean-shaped testicles lie in the abdomen. Operation is performed between the second and third weeks of life, when the habit of crowing commences and the comb assumes a red colour. An assistant holds the bird on its back in his open hands, with its beak pointing towards the operator, and presses down the feet with his thumbs. The feathers are plucked out or cut away for a distance of about $\frac{3}{4}$ inch in front of the anus, and a transverse incision about $1\frac{1}{4}$ inches in length made through the thin abdominal wall. At this stage care is required to avoid damaging the abdominal contents. The incision is preferably made with button-pointed scissors, the thin abdominal wall being raised in a fold with dissecting forceps, incised with scissors, and the incision enlarged to the necessary extent. The operator then passes the disinfected index finger of the right hand into the abdominal cavity to the spot where, externally, the posterior angle of the scapula may be felt on the ribs, meanwhile pressing the abdominal contents to one side. At this point there lies, on either side of the vertebral column, a firm body, the size of a horse-bean—the testicle—which is first separated from the ribs by means of the bent finger, and then drawn backwards through the wound where it is simply pinched off.

The removal of the testicle is indeed scarcely necessary, it being sufficient to remove it from its original position. Any protruding bowel is returned, and the wound in the abdominal wall united with closely placed stitches. The bird is placed alone in a dry run, and is given soft food and clean water. Recovery is complete in about eight days.

Complications during Castration of Male Animals.

1. Adhesion of the Testicle to the Tunica Vaginalis Reflexa.—This condition is only of importance in the operation with exposure of the testicle, and the adhesion may often be simply broken down by means of the thumb or round-pointed scissors. Where it is more extensive and firm, as shown by the fact that the testicle fails to protrude after incision, although it may even have been incised, a second incision may be made to one side of the testicle and enlarged with button-pointed scissors until the testicle is freed. In the event of this also failing, the tunica vaginalis can be divided with scissors above the testicle or epididymis, and the base of the tunic removed together with the testicle. Should the adhesion extend to the spermatic cord, castration must be completed by the covered method. Such adhesions are said to be very common in Russia in consequence of the scrotum being frozen.

2. Prolapse of the Omentum.—In horses and swine portions of the omentum are not uncommonly found in the scrotum, although large portions should be recognised on examining the scrotum prior to operation. Smaller pieces may escape observation, however, and when the tunica vaginalis is opened, often become greatly enlarged in a short time, in consequence of the animal straining. The condition is seldom dangerous. The operator waits until the straining ceases, gently draws the piece of omentum forward, and, if it be limited, snips it off with scissors. Should it contain important blood-vessels, these must be ligatured with sterilised catgut or silk, cut through, and the remainder of the omentum returned into the inguinal canal and thrust back into the abdominal cavity. The omentum seems little prone to inflammatory processes; danger of peritonitis is small.

3. Prolapse of the Bowel.—Though prolapse of omentum is seldom of particular importance, that of the bowel is very serious. In order to avoid this complication, the scrotum and spermatic cord must be very carefully examined before castration. A loop of bowel may, however, pass into the inguinal canal during operation, or a portion too small to be recognised with certainty by external manipulation may have been present in the tunica vaginalis beforehand. Under such circumstances, the prolapsed portion very rapidly increases in size

during operation, in consequence of the animal's struggles. Prolapse is favoured by dragging on the spermatic cord, which dilates the inner abdominal ring. It occurs oftenest in old stallions, either during castration or after the animal has risen. Occasionally it appears later, sometimes when the clams are removed.

Immediately the bowel appears, however small may be the portion, the animal should be placed on its back and the hind quarters raised as high as possible. The greatest care should be taken to prevent the bowel being soiled or injured. Whilst the animal is being moved, the operator should firmly grasp the scrotum to prevent the prolapse further developing, which, under some circumstances, it very rapidly does. As soon as straining ceases, the bowel must be returned through the inguinal canal into the abdominal cavity. Should this prove difficult, the operator may pass one arm into the rectum and assist reposition by pulling on the affected portion of bowel. Under some circumstances, anæsthesia and enlargement of the inner abdominal ring may become necessary.* To prevent a recurrence of the prolapse, clams are applied to the tunica vaginalis; as in herniotomy for inguinal hernia, the tunica vaginalis may be twisted around its long axis. After-treatment is similar to that in the operation mentioned.

4. Entrance of Air into the abdominal cavity is, of course, only possible when the tunica vaginalis is opened, and is recognised by a sudden gurgling or bubbling noise. It is favoured by abnormal patency of the inner abdominal ring, is of rare occurrence, seldom of much importance, and only dangerous when blood passes into the abdominal cavity along with the air. In such case peritonitis may result from the introduction of infective material. Immediately the noise is heard, the operation wound should be covered with the hand. Air which has entered cannot be removed artificially from the abdominal cavity, but is soon absorbed, and is usually uninjurious.

Unfavourable Consequences of Castration of Male Animals.

No special treatment is necessary after castration. Horses are placed in a quiet stall provided with clean bedding. They should be tied up, and, for a time, kept under observation, in order to see whether straining occurs, in which case the animal must be checked by calling to it or by striking it lightly with a whip, as prolonged straining might easily cause prolapse of the bowel. For the next few days—or, after castration with clams, from the day when the clams are removed—

* For a description of the latter operation, see the writer's translation of Möller's 'Veterinary Surgery,' p. 257.

the animal is walked for a half to one hour daily; in the country it may be put to light work. Movement favours the escape of discharge, and also tends to prevent the spermatic cord adhering to the skin wound, or the wound itself closing, which is sometimes followed by severe local inflammation, burrowing of pus, and abscess formation.

During the first few days after operation it is therefore advisable to cleanse the wound with boiled water or a disinfecting fluid at least once daily, in order to prevent the edge of the scrotal wound adhering. At a later stage this cleansing process is necessary for the removal of pus, and must therefore be continued until suppuration ceases. Provided no marked swelling or other complication appears, the animal may be returned to light work in from eight to ten days.

The most serious consequences of castration are:

1. Bleeding. Apart from trivial skin bleeding hæmorrhage is almost entirely confined to cases where the spermatic cord has been twisted, scraped, or torn through, and is very rare after castration with clams. Even after torsion, etc., fatal bleeding is rare. The trifling hæmorrhage resulting from division of cutaneous vessels occurs only in drops, is of no importance, and always ceases of itself. Sometimes, however, blood escapes in a fine stream, and the operator's first task is to discover whence it comes. It may discharge from the side of the clams, and is then usually derived from the skin wound or processus vaginalis; such bleeding may be readily checked by the use of tampons. Should it originate from the stump of the spermatic cord and discharge below the clams greater care is required, and ligation of the bleeding vessel becomes necessary. The slight bleeding which sometimes follows castration by torsion may be stopped by plugging the scrotum with tampons; more severe bleeding calls for ligation of the spermatic cord. The operator slips a loop over the left hand, with which he seeks for the spermatic cord: as soon as this is grasped, the right hand passes the loop around the cord; with the help of an assistant the operator then draws the loop tight, without, however, knotting it, as it may become needful to remove the ligature during the next few days. The ends are left sufficiently long to protrude beyond the operation wound.

When the clams are removed bleeding sometimes results from tearing of small veins. Some care is therefore required in removal; the best preventive of bleeding is to leave the clams in position for two or three days. As a rule, hæmorrhage of this kind ceases spontaneously, but should it persist, the affected side of the scrotum may be plugged with cotton wool or tow. In the case of a stallion that had been castrated three weeks before, Dotter checked bleeding by inject-

ing forty-five minims of a 10 per cent. solution of ergotin; bleeding stopped in twelve minutes.

2. Excessive swelling in the neighbourhood of the castration wound, especially about the sheath. As a rule, severe swelling is due to retention of discharge, consequent on the edges of the wound adhering, or to the operative wound having been too small. Long rest in the stable also favours retention of discharge and swelling. Should the operator be unskilled in grasping the testicle, he is apt (especially in foals) to make the incision too far back; the anterior portion of the scrotum then forms a pocket in which discharge accumulates, producing great swelling of the sheath. Exercise both favours discharge and tends to prevent adhesion between the spermatic cord and surrounding tissues, which in itself is a frequent cause of discharge being retained. In other cases swelling results from virulent infection of the wound. This can only be prevented by proper attention to cleanliness, for which reason dusty places should be avoided for operating, and the straw bed should previously be moistened.

When unusual swelling occurs, the disinfected finger should be inserted in the operative wound, and attempts made to secure free exit for discharge. As a rule discharge accumulates more frequently when the spermatic cord is adherent to the edges of the wound, for which reason the spermatic cord is first sought for and the index finger passed round it in order to break down adhesions; the wound is then rinsed out with a disinfecting fluid, after which the animal is given walking exercise. Virulent infection is best avoided by observing the principles of antisepsis.

3. Castration fever. After castration without antiseptic precautions, trifling fever often appears, even within twenty-four hours. According to Fröhner's observations on 190 horses, it occurred in all but 27 per cent.; 49 per cent. showed moderate, 18 per cent. somewhat severe, and 5 per cent. high fever. Fever most frequently appears soon after the clams are removed, especially if this be done within the first two days after castration.

Where fever is moderate, the animal should receive walking exercise for half an hour a day. Should the temperature in the horse rise above 103° F., the wound must be carefully examined with the disinfected forefinger, any discharge allowed to escape, and the parts washed out with a disinfectant. As a rule the temperature then falls in a few hours.

4. Septic fever is evidenced by high rise in temperature, frequent pulse, and severe general disturbance. The pulse, which in simple wound fever scarcely rises above normal, is then not only frequent,

but small and weak, and the appetite is usually completely in abeyance, even water being sometimes refused. Not infrequently, the castration wound shows no swelling whatever, a symptom which, when associated with high fever, is always serious. On the other hand, severe and widespread swelling, sometimes extending as far as the breast, may occur. Such symptoms call for energetic treatment. The most important point is to thoroughly and repeatedly cleanse the wound with a lukewarm disinfectant; other symptoms must be treated as they arise. Careful regard to cleanliness during operation is the best safeguard against such complications, and it is worth remembering that the directions given to the owner regarding the cleansing of the operation wound are often entirely disregarded. A perfectly new sponge or piece of linen which has been thoroughly boiled in clean water should be used; with this sponge and the cooled water the cleansing is performed; the operation is easy and entails little expense.

5. Peritonitis. Inflammation of the peritoneum may follow castration either in consequence of the wound being septically infected, or of discharge being retained. In either case infectious material is carried upwards by the stump of the spermatic cord from the neighbourhood of the scrotum towards and eventually into the peritoneal cavity. High fever, restlessness, abdominal pain, and loss of appetite are the most important symptoms. Treatment consists in thoroughly cleansing the wound and providing for escape of discharge. Should peritonitis accompany septic infection, the prognosis becomes extremely grave.

6. Prolapse of the spermatic cord consists in protrusion of the spermatic cord beyond the wound in the scrotum. It may be caused by dragging on the cord, by applying the clams too low, or by using too heavy clams. Prolapse is not infrequent in weakly animals, especially if the adhesions between the spermatic cord and outer skin be not broken down when the clams are removed. Should the spermatic cord not be soon returned into the scrotal wound or tunica vaginalis a spermatic fistula results and is often succeeded by scirrhous cord, a condition which will more fully be described in a later volume.

When prolapse accompanies castration with clams, the clams should be removed, and attempts made to release the prolapsed cord and thrust it back again into the processus vaginalis or scrotum. A strong stream of cold water directed on the parts often results in the cord being retracted. Failing retraction, another pair of clams must be applied at a higher point, or the cord be ligatured above the prolapsed part.

7. Abscess formation in or about the scrotum results from retention of discharge, from the primary incision being made at the wrong point, or being of too small size. The decomposing discharge leads to suppurative inflammation in the connective tissue and finally to abscess formation. In this case the swelling is more marked at the spot where the abscess will finally break, and is often hemispherical in shape. Immediately such symptoms are noted, the wound must be examined, and the abscess cavity freely exposed or a counter-opening made. Occasionally it is advantageous to insert a drainage-tube.

Cryptorchidism and the Castration of Cryptorchids.

In the horse and dog, less frequently in other species, the testicles are sometimes either absent or in a state of rudimentary development. Leisering found the testicles of a stallion, which had ineffectually covered forty mares, almost normal in size, but flabby in texture, wanting the tense normal character. Their arteries were distended, their connective tissue thickened, the semen watery, transparent, and containing many round-cells, but only isolated spermatozoa. Testicles which have been retained in the abdominal cavity often show similar appearances. This condition (retentio testis) is not infrequent in stallions of the coarse, heavy variety, but is also seen in other animals. Leisering and Gurlt found the testicles of a dog still in the abdominal cavity; Preusser has seen the same thing in pigs, and Kaiser in bulls. Imminger considers the cryptorchid condition as common in bulls as in horses, and he was able to establish the hereditary character of the condition in certain cases. This abnormality is termed retentio abdominalis when the testicle lies near the upper wall of the abdomen, retentio iliaca when it is near the inner abdominal ring, and retentio inguinalis when it is within the inguinal canal. The apparent absence of one or both testicles thus produced is termed monorchismus or cryptorchismus. During the first few months of life in the foal the testicles certainly lie in the inguinal canal, but towards the end of the first year they again descend into the scrotum.

Gurlt saw a horse in which the testicles occupied a very rare position, viz. in contact with, and adherent to, the diaphragm. Sometimes they lie outside the abdominal cavity, but not in the scrotum (ectopia of the testicle); thus the testicles have been found below the diaphragm or in the crural canal: the first condition is termed ectopia abdominalis, the latter ectopia cruralis. In dogs Möller has found one or both testicles lying beneath the skin next the glans penis; in a bull, one testicle was met with in the subcutis of the flank.

Supernumerary testicles are said to have been seen in horses and mules. Cox found three testicles in a certain horse, and Oliver as many as four in a mule. The accuracy of these observations may, however, be questioned, as a thorough description of the supernumerary organs is wanting, and one cannot help thinking that these were cases of mistaken diagnosis.

The significance of all these conditions is self-evident. Both anorchidism and defective development of both testicles make the animal useless for stud purposes. The same is usually also true of cryptor-

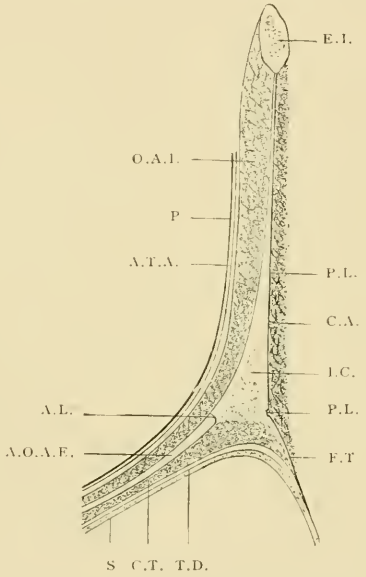


FIG. 250.—Section through the walls of the left inguinal canal. The section is through a line drawn from the centre of the lower abdominal ring to the antero-external angle of the ilium.

S. Skin. C.T. Connective tissue and fascia beneath the dartos. T.D. Tunica dartos. A.O.A.E. Aponeurosis of the obliquus abdominis externus muscle. A.L. Anterior lip of the lower abdominal ring. P.L. Posterior lip of the lower abdominal ring. I.C. Inguinal canal and its contained connective tissue. O.A.I. Obliquus abdominis internus muscle. A.T.A. Aponeurosis of the transverse abdominal muscle. P. Peritoneum. P.L. Poupart's ligament. F.T. Fascia of the thigh. C.A. Crural arch. E.I. External angle of the ilium.

chismus, for testicles when retained in the abdominal cavity are generally atrophic, lax, and either contain degenerated spermatozoa or none at all; on the other hand, retained testicles sometimes yield abundance of spermatozoa. The question of the fertility of cryptorchids was first raised by Gurlt when studying the function of the spermatozoa; his experiments seem to deny fertilising power under such circumstances, for he was unable to discover spermatozoa in the retained testicle. Since then the same question has been variously

answered. Peters considers such animals not fertile, though quite capable of coitus. Wesche, on the other hand, states having seen fertile cryptorchids; he refers, however, to a case of cryptorchismus inguinalis. A final answer can scarcely be given. The animal's fertility clearly depends on the development of the testicles. The great majority

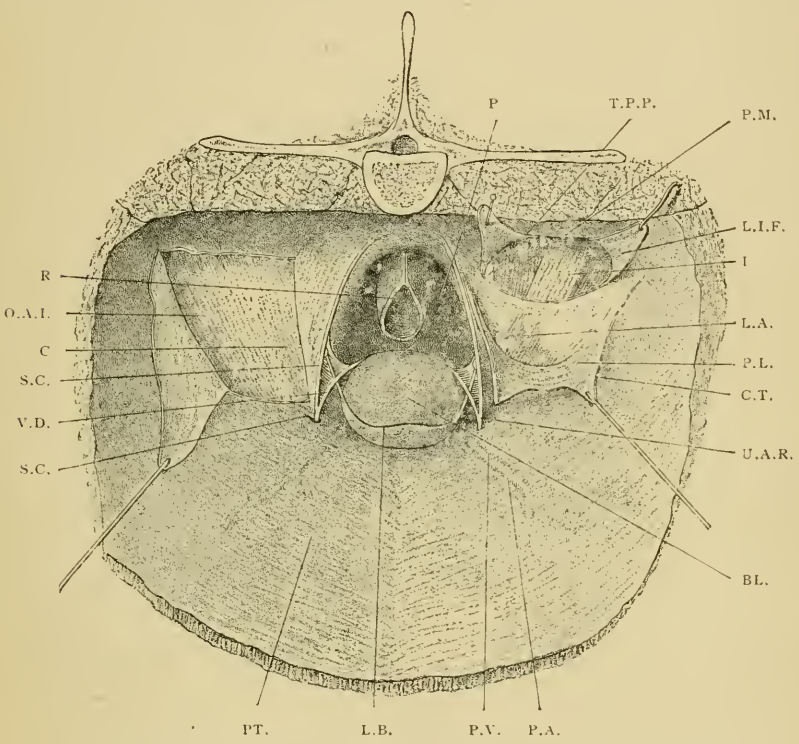


FIG. 251.—Transverse section in a perpendicular plane through the posterior abdominal region, together with a part of the supralumbar, iliac, and prepubic regions (normal).

PT. Peritoneum. P.A. Branch of prepubic artery. P.V. Branch of prepubic vein. U.A.R. Upper abdominal ring. S.C. Spermatic cord. V.D. Vas deferens. P.L. Poupart's ligament, turned downwards, the deep surface visible. L.A. Long adductor of the thigh. L.I.F. Lumbo-iliac fascia. I. Iliacus. P.M. Psoas magnus. T.P.P. Tendon of the psoas parvus. P. Pelvis. R. Rectum. BL. Bladder. L.B. Lateral ligaments of the bladder with the obliterated umbilical artery. O.A.I. Internal oblique abdominal muscle. C. Cremaster. C.T. Layer of connective tissue which surrounds the upper border of Poupart's ligament, the posterior margin of the internal oblique abdominal muscle, the cremaster, and the peritoneum.

of retained testicles certainly appear degenerated, and contain no spermatozoa. Paugoué speaks of a stallion in which both testicles were retained, and whose progeny numbered amongst them five cryptorchids or monorchids, thus apparently proving the condition to be hereditary.

The retained testicle is often the seat of dropsical cysts and not infrequently malignant new growths like sarcoma, carcinoma, etc. Leisering, in the case of a dog, found the retained testicle attacked with cancer; the same condition has been seen in horses. In man, such testicles still more frequently become diseased. so that early removal is generally necessary.

The same necessity does not exist in the horse, though removal often becomes desirable on account of sexual excitement (particularly in spring) greatly interfering with the animal's usefulness. Many cryptorchids are too vicious for use. The flesh of cryptorchid swine has usually a repulsive taste, which, according to Koch, is retained even by the salted meat, and is more intense the more completely the testicles have developed.

Diagnosis is sometimes very easy, but, on the other hand, is sometimes very difficult; the exhibition of sexual appetite alone is not a reliable symptom, for "rig" horses sometimes behave like geldings and geldings like stallions. Nor is the castration scar to be relied on. The operator may have removed both testicles through one incision, or, as more frequently happens, he may have opened one side of the scrotum without finding the testicle.

Cadiot states that where the testicle has really been removed the scar always shows a funnel-shaped depression surrounded with wrinkles; by passing the finger from before backwards along the sheath, a cord, varying in size between a goose-quill and the little finger, can almost always be felt; this represents the stump of the spermatic cord, and can be traced as far as the inguinal ring. On the side of the retained testicle this cord is absent, and instead, one feels a triangular groove. Occasionally the gubernaculum testis is unusually developed, and may be mistaken for the stump of the cord, but in such case the cicatrix is absent.

To distinguish between inguinal and abdominal cryptorchidism Cadiot proposes the following method of examination:—The points of the fingers are brought together, forming a cone, and are pushed towards the inguinal ring; the testicle when in the canal is recognised as a rounded, thick, movable object. By examining the inner abdominal ring of either side *per rectum* there will be found on the side of the retained testicle a thin cord passing into the ring, which cord cannot be caused to move by drawing the sheath downwards. Should the animal have been castrated, however, the cord will descend as soon as an assistant moves the sheath.

Where the testicle lies in the abdomen itself the inguinal canal is necessarily empty, and the space usually lined by the tunica vaginalis

communis is absent. To find the testicle under these circumstances Möller recommends passing the hand into the rectum, and after first discovering the anterior edge of the os pubis examining the floor of the abdomen with the outstretched fingers in front of, and for four to six inches on either side of, the linea alba. As a rule, the testicles are soon found; in other cases the rectum requires to be thoroughly emptied and the search renewed. Should the operator be in doubt as to the nature of the body found he may compress it, when, in the event of its being the testicle, the horse usually struggles. Degive passes the hand downwards along the sides of the abdomen to the middle line.

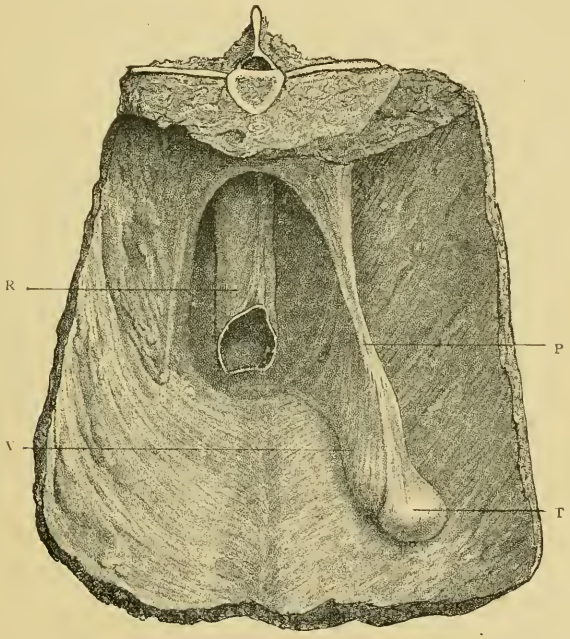


FIG. 252.—A case of abdominal cryptorchidism.
T. Testicle. P. Fold of peritoneum surrounding the spermatic cord.
V. Vas deferens. R. Rectum.

Fröhner endeavours to draw the testicle backwards towards the pelvic cavity, in order to bring it into a better position for examination. Masses of fæces sometimes mislead the operator, but may be distinguished from the testicle by the fact that they are usually firm and rounded, and may be broken down without causing pain, whilst the testicle is flat, flabby, sharply marginated, very easily displaced, always retains its shape, and is sensitive to pressure. Sand compares the feel of the testicle to that of a small bag filled with mercury. The above examination is only for the purpose of determining whether the testicle

is or is not retained, and is of no value for operative purposes, inasmuch as the position of the gland is often entirely altered when the animal is cast. Furthermore, it should not be deferred until immediately before operating, as the soiling of the hands and arms immensely increases the difficulty of properly disinfecting them.

The anatomical relations of the parts are very clearly shown in the accompanying figures, redrawn from Cadiot's work.

Fröhner divides the methods of operation into two groups, viz. the inguinal and ventral.

In the inguinal operation the incision is made in the neighbourhood of the outer abdominal ring, and extended by blunt dissection towards the inner abdominal ring, in the neighbourhood of which the abdominal cavity is opened. In the ventral operation laparotomy is performed either in the region of the flank or from the lower surface of the abdomen.

Cadiot recommends only castrating such rig horses as are dangerous or difficult to handle, and in other cases abstaining from operation. He considers the beginning of the fourth year the best period, as the descent or partial descent of the testicle often occupies a long time, and when the testicle is only partially developed the inguinal operation proves difficult and sometimes dangerous. The operation demands care and practice, but with antiseptic precautions loses much of its danger, and is often of great service.

The operation is easiest in horses which have been kept low for some weeks and are in thin condition, because in them there is less fat in the inguinal region. Some days before operation a dose of physic is given to empty the bowel, and from that time the animal receives only a limited amount of concentrated food like oats, with a little hay, but no straw. On the morning of operation the bowel is emptied by a subcutaneous injection of arecolin. Clysters are contra-indicated.

Thus prepared, the horse is cast on the side opposite the seat of operation; the hind quarters are half rolled over, and lie somewhat higher than the fore. The upper hind foot is then drawn forward and fixed in a position of abduction and flexion, as in ordinary castration. By previously cleansing the hoofs and lower part of the limbs and surrounding them with moist cloths, and by moistening the hair on the upper part of the thigh the point of operation is protected against infection.

Three dishes, each containing 2 to 3 per cent. carbolic or 1 per cent. chinosol solution, are necessary. After boiling, the instruments are

placed in one and the ligatures and needles in the second; the third is used by the operator for moistening his hands before introducing them into the abdominal cavity; in a fourth empty dish, pledgets of sterilised cotton wool are in readiness. It is also well to have at hand a vessel with a lip, to use as an irrigator.

All being ready, the animal is chloroformed, during which time the

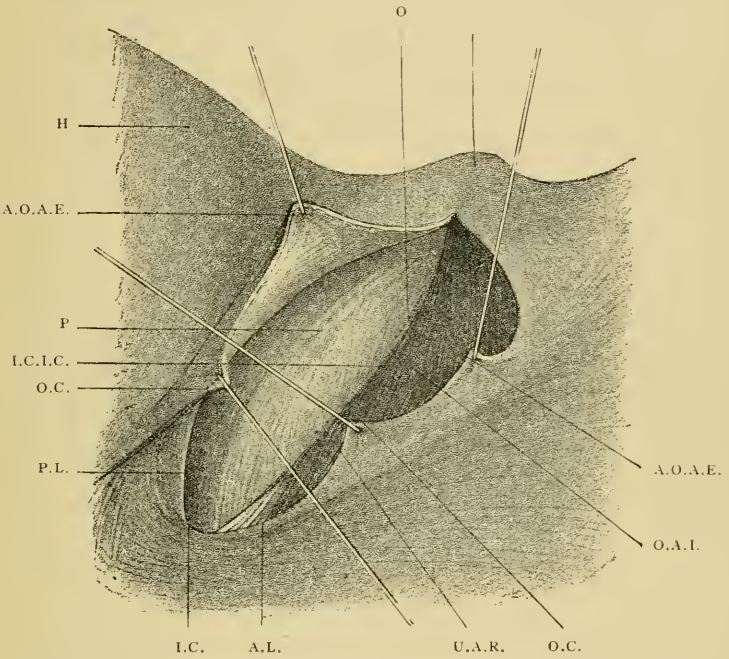


FIG. 253.—Inguinal canal, viewed from the flank. The external lip of the left inguinal ring has been removed. The aponeurosis of the external oblique abdominal muscle has been cut through a little in front of the spot where it divides. The inner oblique abdominal muscle has been separated from Poupart's ligament to a point near the inner commissure of the inguinal canal. P. Poupart's ligament. O.A.I. Obliquus abdominis internus muscle. I.C.I.C. Inner commissure of the inguinal canal. A.O.A.E. Aponeurosis of the obliquus abdominis externus muscle divided and reflected. I.C. Inner commissure of the lower abdominal ring. O.C. Outer commissure, divided. A.L. Anterior lip. P.L. Posterior lip. U.A.R. The dotted line indicates the position of the upper abdominal ring. O. The dotted line indicates the position in which the opening is made in operating for abdominal cryptorchidism. H. Hind limb, abducted.

seat of operation is scrubbed with soap and water, washed with ether or turpentine, and disinfected with carbolic or sublimate solution. The inguinal region, sheath, lower surface of the abdomen, and inner surface of the thigh must all be included. The disinfected sheath is plugged with a tampon of cotton wool. As soon as narcosis is complete, the assistants holding the dishes place themselves near the

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operator, who has carefully disinfected his hands and arms and thrust his sleeves back above the elbow. The position is the same as in castration. The operation is divided into the following stages:

1. *Incision.*—An incision is made through the skin, about two to three inches long, over the outer inguinal ring (perhaps slightly nearer the middle line) and parallel with it, and the subcutaneous tissue and fascia lying at this point are divided to the same extent. Any bleeding vessels are at once ligatured, and blood removed with sterilised pledgets of tow.

2. *Opening the inguinal canal.*—The loose connective tissue in the inguinal canal must now be thrust on one side, both index fingers and possibly the thumbs being employed, and an entrance effected in the direction of the inner abdominal ring. The index and middle fingers of the hand corresponding to that particular side of the animal are then passed into the inguinal canal to make sure whether the processus vaginalis and remainder of the spermatic cord lie there. Should the testicle be met with at this stage (retentio inguinalis), the operation becomes very simple, being, in fact, just like ordinary castration. Sometimes a more or less degenerated process of the tunica vaginalis, perhaps as large as the finger of a glove, together with the end of the epididymis, may be felt in the inguinal canal. In that case the inner abdominal ring must be examined by introducing the index finger, and its width discovered. Generally it is very narrow, and would not even permit the passage of the rudimentary testicle. As it is difficult to dilate, I prefer in such cases to ignore the process of the tunica vaginalis, and seek an entrance to the abdominal cavity alongside of it. When the inner abdominal ring appears wider, the processus vaginalis is to be divided and the operation continued as after perforation of the abdominal walls.

3. *Perforation of the abdominal walls.*—By passing the fingers, nearly to the last knuckle, into the inguinal canal, the abdominal wall can be felt in the depths. The posterior border of the obliquus abdominis and the fibres of the obliquus internus can be clearly distinguished. Close behind the latter is a mass of loose connective tissue. Degive makes his perforation at this point. Like Bang, I prefer entering through the inner oblique abdominal muscle at the inner wall of the inguinal canal, somewhat nearer the median line than the inner abdominal ring. This produces a "button-hole wound," which does not gape, but, on the contrary, soon comes together again and prevents prolapse of the bowel. A vigorous thrust with the index and middle fingers during inspiration carries them through the abdominal wall into the peritoneal cavity. Different animals, however,

present great differences in this respect; in some perforation is easy, in others it requires considerable force.

4. *Finding the testicle or spermatic cord* is always the most difficult part of the operation for the unpractised: nevertheless it can generally be effected with the first two fingers, and without introducing the entire hand. As soon as the abdominal wall is perforated, search is made on all sides for the testicle, epididymis, or spermatic

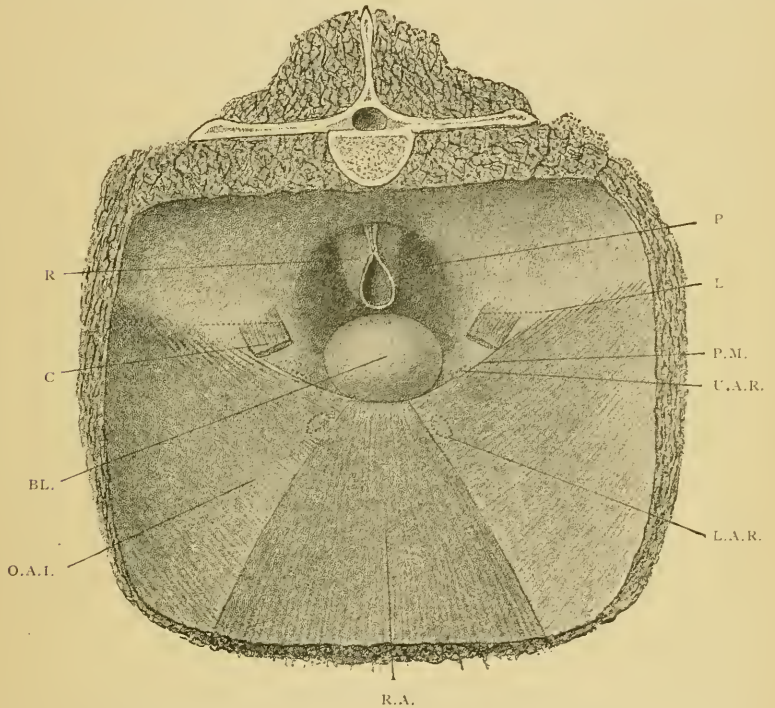

FIG. 254.—Transverse section of the posterior abdominal region in a vertical plane. This figure shows the insertion and arrangement of the obliquus abdominis internus and the cremaster. The peritoneum and transverse abdominal muscle have been removed.

O.A I. Obliquus abdominis internus. P.M Posterior margin of same. C. Upper portion of the cremaster muscle (divided). R.A. Rectus abdominis muscle. L.A.R. The dotted line shows the position of the lower abdominal ring. U.A.R. The dotted line indicates the upper abdominal ring. L. The dotted line shows the point at which the hand pierces the peritoneum in the operation for abdominal cryptorchidism. P. Pelvis. R. Rectum. BL. Bladder.

cord. The testicle may easily be mistaken for an empty loop of bowel, but is distinguished by its sharper outline and greater firmness; pressure on it causes struggling. The end of the epididymis is recognised as a soft mass, containing harder, firmer cords. The spermatic duct can be felt as a hard cord, and is very useful for discovering and drawing forward the testicle, for its slight size and

thread-like hardness render it easily recognised. It can, moreover, be brought forward with much less difficulty than the testicle itself, which, when grasped and pulled on, causes struggling. The object to seek, then, is a very small body, possessing a hard, string-like cord (spermatic cord). As a large mesenteric artery might be mistaken for it, the cord should be examined to detect pulsation. It is much easier to discover the spermatic cord than the testicle. When drawn forward, the spermatic cord is recognised by its light colour. By gently pulling on it the testicle is drawn upwards through the opening, though in exceptional cases the testicle may be so large as to offer considerable resistance. As soon as the testicle appears outside the wound, two, or if it be very large, three, carefully disinfected catgut or silk ligatures are passed round the spermatic cord, which is then cut off half an inch below the point of ligation, and allowed to return to the inguinal canal. Not infrequently, however, the cord cannot be brought into the wound. The testicle must then be recognised by touch, and removed with the écraseur. In cases of double-sided crypt-orchidism the operation may be performed on each side in succession, or, if the spermatic cords be sufficiently long, both testicles may be removed through one wound. Some authorities allow an interval of a month to elapse between the first and second operations. The wound is closed with five to eight silk threads, powdered with iodoform-tannin (1—3) or boric acid, and covered with a layer of wood-wool or carbolic wadding. Only when the spermatic cord or wound has been soiled is it necessary to wash out with sublimate solution.

This completes the operation, and the animal can be allowed to rise. Once on its feet, a suspensory bandage can be applied if thought necessary, but must be omitted if the animal be restless. The patient is tied up for four days and kept on half rations, after which it may be allowed to lie down, still wearing the dressings, which are removed, however, after six to eight days.

To diminish the danger of prolapse of the bowel the stall should be higher at the back than at the front, so as to elevate the animal's hind quarters. The tail should be plaited and fastened to one side.

Should the bowel protrude during operation the inguinal canal may be plugged with antiseptic gauze after removing the testicle. The skin must be sutured. Degive also sutures the external abdominal ring. A loop of intestine may descend after operation. In such case attempts may first be made to return it by passing the hand into the rectum and exercising traction, but if the intestine has been exposed to the air the horse must be cast, the gut well disinfected and carefully replaced. Bang sutures the muscular wall of the abdomen or the peritoneum.

Peritonitis or septicæmia is usually rapidly fatal, though the first occasionally takes a chronic course of several weeks before death supervenes.

As a rule, little or no pus is formed, but should it appear, the front and back stitches in the skin wound may be loosened, and the latter washed out once daily with carbolic, creolin, or sublimate solution. Provided fever or loss of appetite is not marked, after-treatment is unnecessary, and the animal may return to work in about fourteen days.

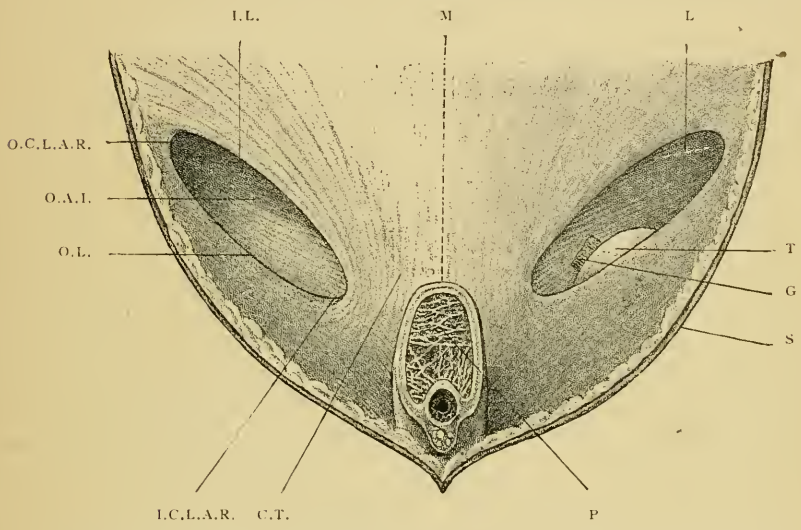

FIG. 255.—The prepubic and inguinal regions seen from below. (On either side of the middle line is visible the lower abdominal ring and the entrance to the inguinal canal.)

I.C.L.A.R. Inner commissure of the lower abdominal ring. O.C.L.A.R. Outer commissure of the lower abdominal ring. I.L. Inner lip. O.L. Outer lip. O.A.I. Obliquus abdominis internus muscle. T. Testicle covered with the tunica vaginalis propria. It has descended as far as the lower abdominal ring (inguinal cryptorchidism). G. Fibrous band representing the gubernaculum testis. L. The dotted line shows the position and direction of the opening made in the obliquus abdominis internus muscle when operating by Bang and Möller's method. C.T. Common tendon of the abdominal muscles. P. Section through penis. S. Skin M. Median line.

Sometimes great difficulty is experienced in finding the testicle. One operator recommends passing the hand towards the bladder, finding the vas deferens, and tracing it back towards the testicle. Occasionally the testicle cannot be found. Even so skilled an operator as Degive failed in four instances; Sand relates two, Bayer one or more. Should it prove impossible to withdraw the testicle Degive divides the spermatic cord, and allows the testicle to fall back into the abdomen. When the enlargement is cystic Degive brings the testicle near the inguinal ring, thrusts a fine trocar through the

abdominal wall, draws off the fluid, and is then able to pull the collapsed gland into the canal and remove it. Professor McQueen ruptures dropsical cysts with the finger and thumb.

If other means of finding the testicle fail, the disengaged hand can be introduced into the rectum, and attempts made to force the testicle through the opening; but this should be a last resort, on account of the difficulty of afterwards disinfecting the hand. Thus exposed, the testicle is secured with a cord covered with cotton wool, the hand which has been introduced into the rectum is at once cleansed and thoroughly disinfected, and the operation proceeds as above described.

When the spermatic cord is very short it renders ligation particularly difficult. Degive under such circumstances employs the écraseur.

In one case Möller was unable to find the testicle. He therefore introduced the entire hand into the abdominal cavity (a proceeding which is much less risky than is often supposed) and discovered a soft body the size of two fists. This he at first took to be the urinary bladder, which further examination showed, however, to be in its normal position, whilst the soft body lay near the inner abdominal ring, was movable, and carried at one end a firm object which resembled a testicle. Convinced that he had to deal with a degenerated testicle, he extended the opening in the skin and abdominal walls sufficiently far to allow the testicle and spermatic cord to be ligatured. After removing the testicle and suturing both the skin and abdominal walls with strong silk (interrupted sutures), recovery occurred without complication.

A closer examination showed that the testicle had almost entirely disappeared, and a cyst containing sixteen ounces of serum, and having a circumference of fourteen inches, had formed in the spermatic cord. At the lower end of the cord lay a lipoma, about the size of a duck's egg, and partly ossified. He was inclined to regard this tumour as the degenerated testicle until his attention was directed by Degive, who has repeatedly seen similar cases in his extensive practice, to hydrocele of the spermatic cord. Degive scratches the hydrocele with the finger-nail until it discharges into the abdominal cavity, when the testicle can easily be removed.

Castration of cryptorchid boars is similar to that of horses, with the one exception that a flank incision is preferable. Levens describes a case where the castrator had removed the boar's kidney instead of the testicle, as was discovered on slaughtering the animal. The other kidney had undergone compensatory hypertrophy.

The ventral operation can either be performed from the flank or the lower surface of the abdomen. Both methods have been recommended, but neither is now much practised.

The horse having been cast and placed on its back, the seat of operation is thoroughly cleansed and disinfected. Günther, who adopted the low operation, made a longitudinal incision of about four to five inches, commencing opposite the free extremity of the sheath and 2 to 2½ inches distant from it and passing backwards. This

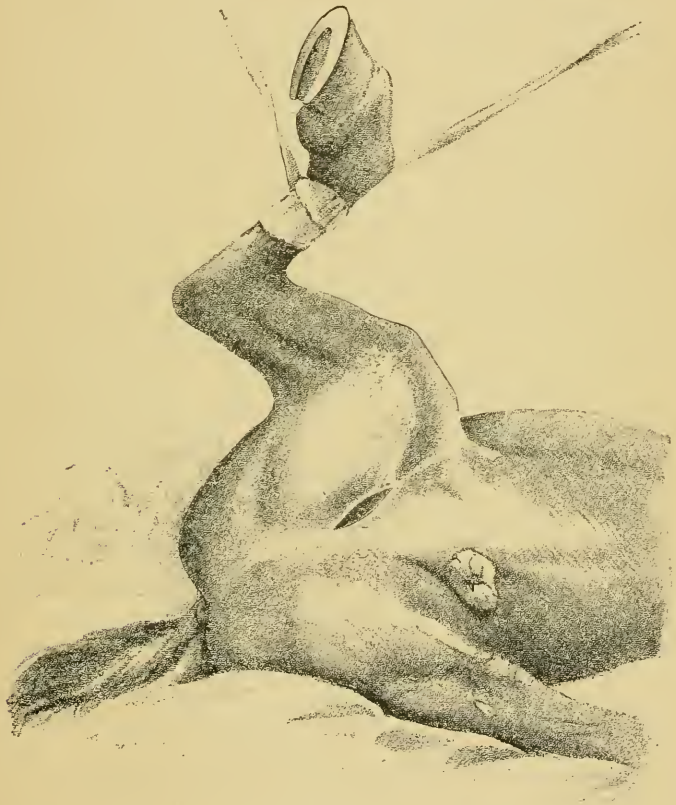

Fig. 256.—Showing position of incision in inguinal operation for cryptorchidism.

incision exposed the yellow elastic abdominal tunic, which was next incised until the rectus abdominis muscle came in view. The rectus abdominis was partly cut and partly torn through as far as the tendon of the transversalis abdominis, the fibres of which were divided; the peritoneum, thus exposed, was penetrated with a sharp thrust with the forefinger. By inserting and spreading out the other fingers the opening in the transverse muscle was sufficiently enlarged in the

direction of the muscular fibres to permit of the hand entering easily. The paralysing effect on the arm, due to muscular contraction, which proves so troublesome in certain other methods, was thus prevented.

Should difficulty be experienced in finding the testicle Günther advised passing the hand towards the bladder, discovering the vas deferens, and following it up to its point of origin in the testicle. Another method consists in finding the spermatic artery at its point of origin, and tracing it as far as the testicle.

Günther strongly recommended this mode of operation, but later authorities by no means support him. Fröhner condemns it entirely. He lost two out of four horses operated on : one died in consequence of the stump of the spermatic cord protruding between the widely spaced sutures in the yellow elastic abdominal tunic and becoming infected, thus setting up fatal peritonitis. In the second case the elastic tunic and the skin were very carefully sutured, notwithstanding which a prolapse of bowel occurred on the fourth day. The bowel was thoroughly disinfected and returned, but septic peritonitis occurred and proved fatal. In the next two cases Fröhner sutured each layer of tissue separately, firstly the peritoneum, then the rectus abdominis, then the yellow elastic tunic, and finally the skin. Both cases did well. Fröhner, however, draws attention to the inconvenience and difficulty of the procedure. Bayer has twice successfully operated by this method.

Castration of Female Animals (Oöphorectomy).

The castration of female animals, consisting in removal of the ovaries, is less frequently performed than the corresponding operation in the male. It is said to have certain valuable economic results ; thus young pigs and cows are thought to fatten more satisfactorily afterwards, and milch cows to remain longer in milk ; bitches are castrated to prevent their breeding, and to avoid the unpleasantness associated with their coming on heat. Sows and cows are the most common subjects of operation, and for this reason will first be considered.

1. Cows not only fatten better, but their milking period is considerably prolonged after castration. As early as 1850 Charlier recommended castrating cows thirty to forty days after the birth of the second or third calf, following which the yield of milk was said to remain steady as at the time of castration. Although this expectation has not been entirely fulfilled, cows are still castrated in order to prolong their milk-yielding period, and to increase their capacity for fattening. The operation has been sporadically revived and again

abandoned. At the time of the writer's stay in Germany and Austria (1892 and 1893) it was extensively practised, but later inquiries show that it has been again relinquished, and is now seldom spoken of. Attempts have also been made to practise it extensively in England, but without much success. Even although peritonitis is avoided, the rumen is apt to become adherent to the wall of the abdomen and digestive disturbance to follow. Hendrickx claims that in one respect castration acts as a prophylactic against tuberculosis, inasmuch as it prevents the bearing of calves by animals suffering from or disposed to this disease. As the calves of old animals are particularly inclined to contract tuberculosis, Hendrickx recommends castrating cows at the age of eight years.

Castration is successfully employed in cows as a cure for nymphomania. Albrecht operated on fifty animals with this object; forty-two were completely cured, in three cases the operation failed, and in five cases was only partially successful. Of twenty-five afterwards operated on, twenty-three were cured. After castration the broad uterine ligaments again become tense, the milk secretion and character of the meat improve, and the proportion of fat in the milk increases.

The old operation of removing the ovaries by the right flank was wisely abandoned in favour of the method introduced by Charlier, viz. removal through the vagina. That the latter deserves preference, except in those cases where strict antisepsis can be observed, is shown by Lanzillotti's observations. At the present time Charlier's method is almost exclusively employed.

In the cow the ovaries lie below the transverse processes of the fourth to the sixth lumbar vertebræ, level with the external angle of the ilium, but about 2 to $2\frac{1}{4}$ inches nearer the middle line. They are nearly the size of walnuts, are flattened, rounded, and of firm consistence, for which latter reason they are easy to recognise. When diseased, however, as in nymphomania, either one or both may be very much enlarged.

Charlier's operation is performed as follows:—The animal, which must be in good health, receives half rations on the evening before, and no food whatever on the morning of operation. The operation is best performed with the animal in the standing position, and in its stall. The head is fastened up short, and two men standing near the hind quarters prevent the animal moving to either side. One of these men holds the tail whilst both grasp a round pole passed under the cow's body to prevent it lying down. In case of severe straining, on the other hand, they place the pole on the cow's back, on which they

press. The rectum is emptied before operation. For this purpose Hoffmann injects six fluid drachms of glycerine. The necessary instruments are—(1) a vaginal speculum; (2) forceps for torsion of the ovaries, or a metallic finger-stall for scraping through their attachments, or, again, a long écraseur; (3) a *bistouri caché*.

Although, on account of the impossibility of thoroughly disinfecting

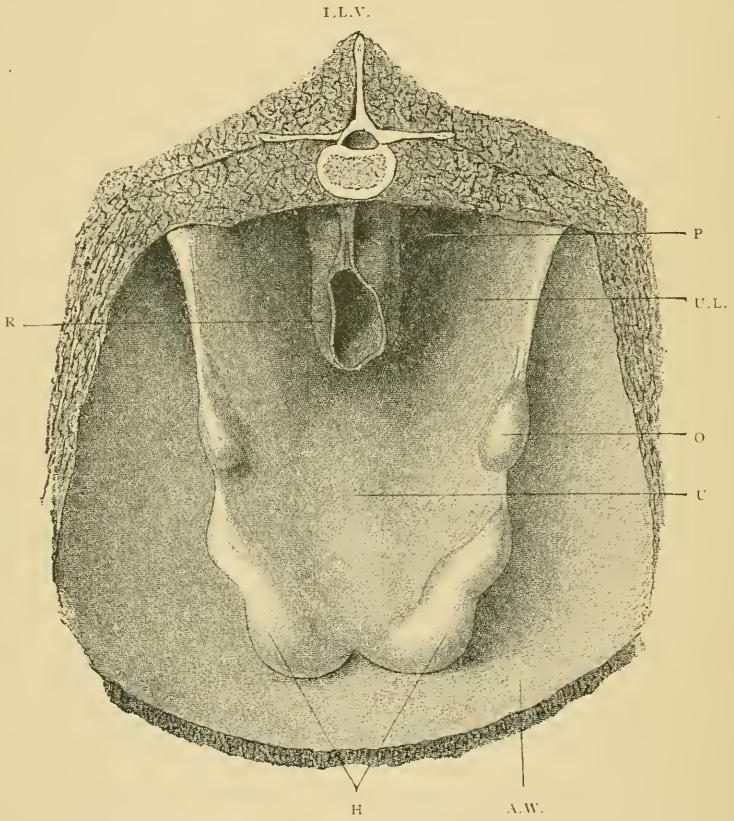

FIG. 257.—Transverse section of the posterior abdominal region in a vertical plane. The subject is a mare, and the section passes just in front of the first lumbar vertebra. The figure shows the position of the uterus as seen from below and that of the ovaries above the broad uterine ligament.
O. Ovary. H. Horns of the uterus U. Uterus. U.L. Broad uterine ligament. R. Rectum. A.W. Abdominal wall. P. Pelvis. I.L.V. First lumbar vertebra.

the vagina, asepsis cannot be insured, yet all ordinary antiseptic precautions should be observed, the vulva and entrance to the vagina being washed with soap and water and freely rinsed with a disinfectant. Hürliman recommends injecting a 2 per cent. carbolic solution into the vagina and afterwards drying the parts with sterilised cotton wool. One per cent. sublimate solution has been recommended for this

purpose, but is unsuitable because it causes severe irritation of the mucous membrane and straining, both of which interfere with operation. Needless to say the hands and instruments must be carefully disinfected.

The vaginal speculum is introduced in the closed condition, and opened by screwing the handle. The right hand, holding the

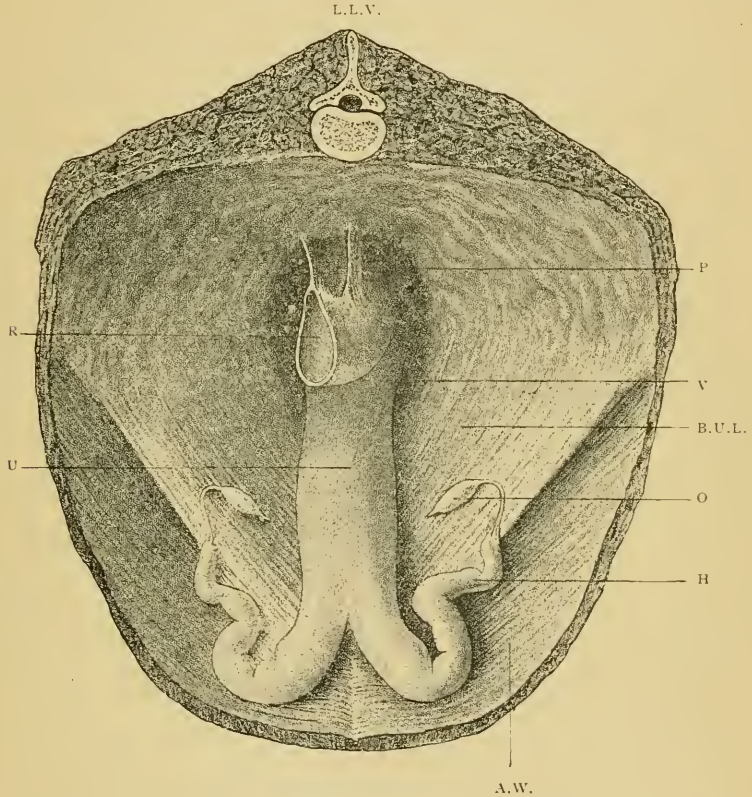

FIG. 258.—Transverse section of the posterior abdominal region in a vertical plane. The subject is a cow, and the vertical plane passes in front of the last lumbar vertebra. The figure shows the position of the uterus and the insertion of the ovaries in the uterine ligaments (seen from above).

O. Ovary. H. Horn of the uterus. U. Uterus. B.U.L. Broad uterine ligament. V. Vagina. R. Rectum. P. Pelvis. A.W. Abdominal wall. L.L.V. Last lumbar vertebra.

closed *bistouri caché*, is then introduced into the vagina, through the upper wall of which an incision about 2 to 2¼ inches in length is made. The bistoury is then laid aside, the vaginal speculum removed, and the index and middle fingers of the right hand are passed through the vaginal wound into the abdomen, where the left ovary is first sought, and drawn into the vagina. The forceps

for twisting off the ovary are next introduced with the left hand, and whilst the right hand, the thumb of which is covered with the metallic thumb-stall, grasps the ovarian ligament, the left slowly rotates the forceps until the ovary is freed. The right ovary is removed in a similar fashion, the right hand, however, taking the place of the left, and *vice versâ*. No special after-treatment is required. Any blood which may have passed into the vagina during operation is removed with the hand or with a clean sponge. The vulva is washed

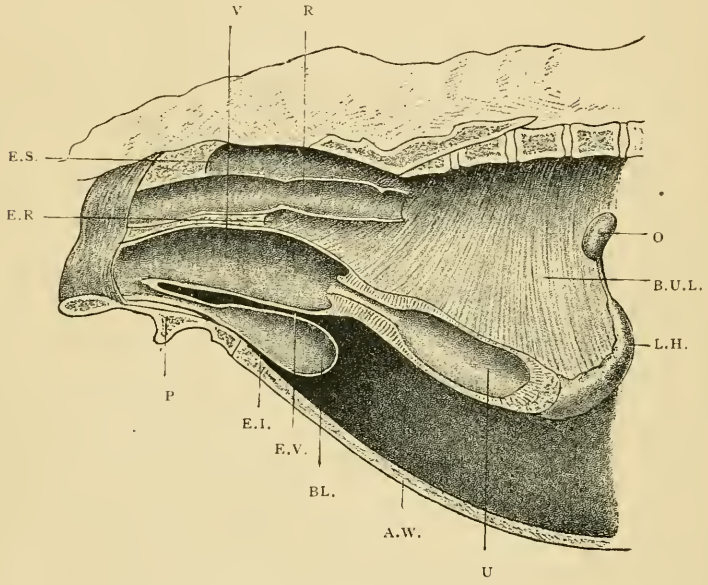

FIG. 259.—Longitudinal section in a vertical plane through the urino-genital organs of a mare.
O. Left ovary. B.U.L. Broad uterine ligament. L.H. Left horn of the uterus. U. Uterus. V. Vagina. BL. Bladder. R. Rectum. P. Section through pelvis. A.W. Abdominal wall. E.S. Excavatio superior. E.R. Excavatio recto-vaginalis. E.V. Excavatio vesico-vaginalis. E.I. Excavatio inferior.

once or twice a day with a disinfecting fluid. Healing proceeds regularly, and without complication. No special difficulty is usually found in operating, and after some practice the operation is not difficult.

When this method became better known many modifications were proposed.

Charlier himself afterwards constructed another form of vaginal speculum, because the arms of the first sometimes proved too weak. Further modifications have since been effected by different operators. Colin incised the upper vaginal wall close behind the os uteri with a

guarded bistoury (Fig. 263), without using a speculum; whilst Richter, in order to avoid injuring the rectum, recommended forming a fold in the upper wall of the vagina, and incising this with a *bistouri caché* fastened to a long arm, or with special long scissors. Hürliman also dispensed with the speculum, and to escape injuring the rectum pressed the lower wall of the vagina downwards towards the bladder. Ostertag recommends incising only the mucosa, and breaking through the muscular and serous coats with the finger.

Danger of injury to the rectum is not great provided the above-described precautions are observed.

When twisting off the ovaries, the lower, thicker portion of the

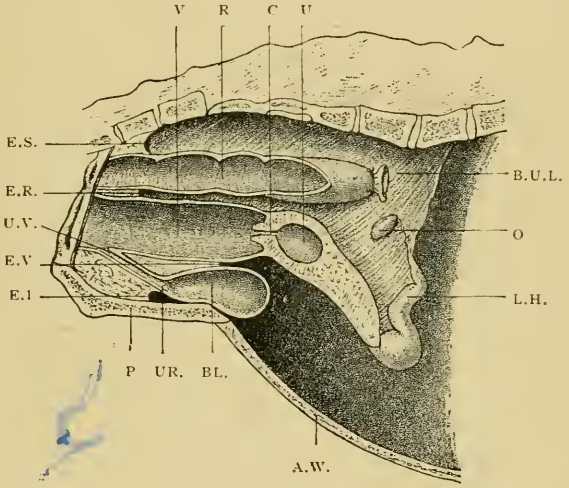

FIG. 260.—Longitudinal section in a vertical plane through the urino-genital organs of a cow.

O. Left ovary. L.H. Left horn of uterus. U. Uterus. B.U.L. Broad uterine ligament. C. Neck. V. Vagina. BL. Bladder. UR. Urethra. U.V. Valve covering the opening of urethra. R. Rectum. P. Section of the pelvis. A.W. Abdominal wall. E.S. Excavatio superior. E.R. Excavatio recto-vaginalis. E.V. Excavatio vesico-vaginalis. E.I. Excavatio inferior.

ovarian ligament may be cut through with long scissors (Fig. 264) and the rest divided by torsion. Special forceps have been invented to fix the ligament. Colin uses for this purpose small iron clams (Fig. 269).

The ovarian ligament is grasped with one or other of these instruments, and the ovary removed with the hand. Should the ovary still be adherent after twenty or thirty rotations, the ligament may be scraped through by means of a steel finger-stall, which, however, is seldom needed, torsion being usually sufficient. Of late years the écraseur has been largely employed for removing the ovaries, but it must be of greater length than usual; it greatly facilitates operation. The

experiment has been tried of simply dividing the ovarian ligament with a knife, but it is dangerous, and may be followed by severe bleeding or even by death. Hürliman divides the ovarian ligament with scissors up to the point through which the artery passes,

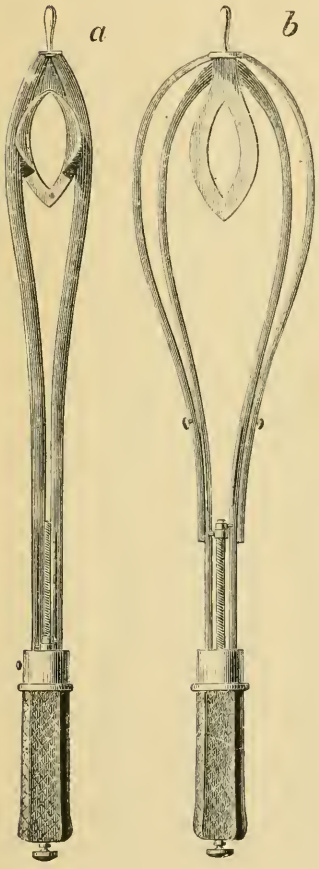

FIG. 261.—Charlier's vaginal speculum (early form).

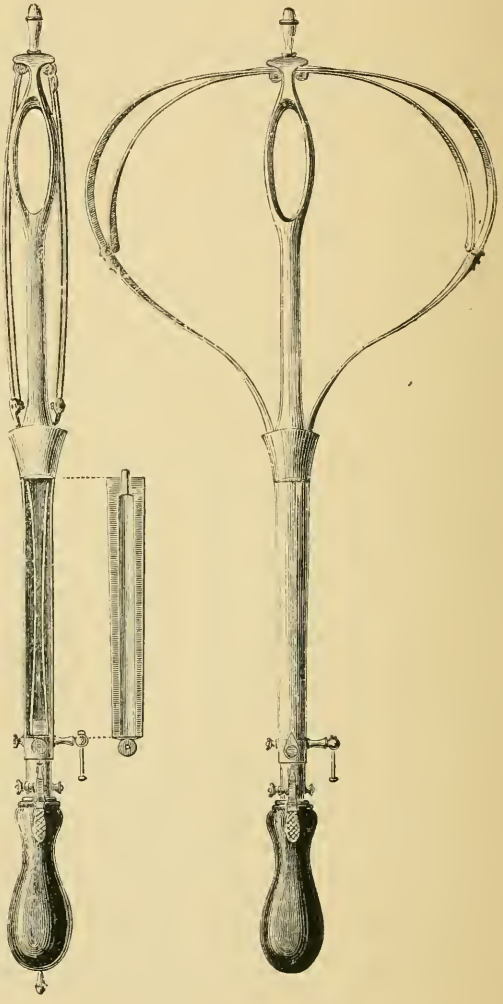

FIG. 262.—Charlier's vaginal speculum (later form).

and ligatures the vessel with sterilised silk. The artery may be identified by its pulsation.

To prevent air and infective material entering the peritoneum it has been recommended not to draw the ovary into the vagina, but to pass

a ligature provided with one short and one long end over the thumb, index, and middle fingers of the left hand and into the abdomen, to slip the loop over the ovary, and draw it tight with the right hand. The ends are cut off about three eighths of an inch from the knot, and the ovary usually removed at a similar distance from the ligature. One operator claims to have removed both ovaries in twelve minutes.

Without doubt this method securely guards against bleeding, but whether it guards equally well against peritonitis appears very doubtful. Even though ligatures are carefully sterilised they are very apt to become soiled in the vagina, and so cause peritonitis. For this reason removal of the ovaries by torsion or by the écraseur appears preferable, and offers equal security against bleeding.

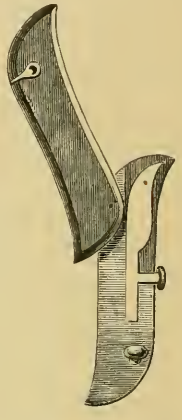

Fig. 263.—Guarded bistoury for incising upper wall of vagina.

Hoffmann describes the antiseptic method. The vulva and neighbouring parts are thoroughly brushed with warm soap and water, warm water is injected into the vagina, and the parts are cleansed with the disinfected hand. After removing the water with the hand or with the help of a rubber tube, Hoffmann rinses out the vagina with a disinfecting fluid, such as a 3 per cent. creolin solution, and again washes it with the left hand. The speculum is then passed as far as the os uteri with the same hand, and the right hand, carrying a *bistouri caché*, being introduced, an incision is made through the upper wall of the vagina. The right hand is then passed

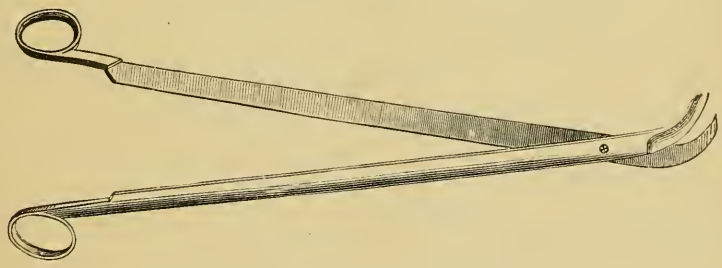

Fig. 264.—Scissors for dividing ovarian ligament.

through the opening into the peritoneal cavity, the left ovary is found, grasped between the index and middle fingers, and drawn into the vagina, where it is twisted off by means of forceps. The right ovary is removed with the left hand. To prevent straining after operation a pole is passed over the animal's loins. A few hours after the operation the temperature rises to 102–3° F., but falls to normal within the next

few days. Should it, however, remain high, the vagina is washed out with creolin solution.

2. Female lambs are seldom castrated. Obich operated on ten weeks old animals from the left flank. The incision was sufficiently

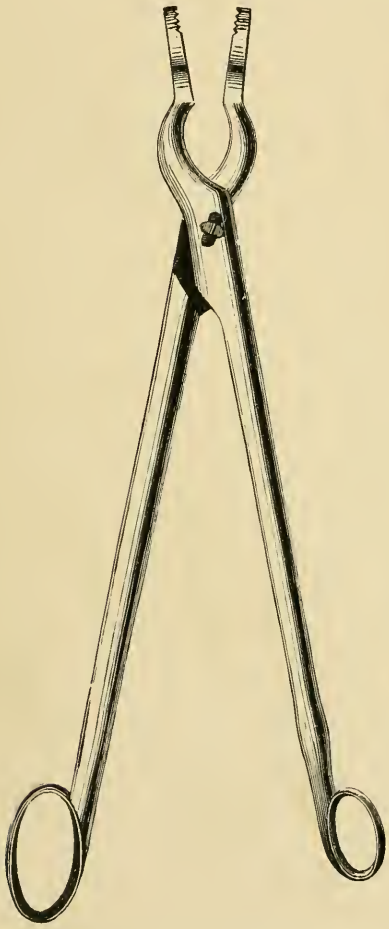

Fig. 265.—Forceps for grasping ovarian ligament in torsion of the ovary.

Fig. 266.—Forceps for grasping ovarian ligament in torsion of the ovary.

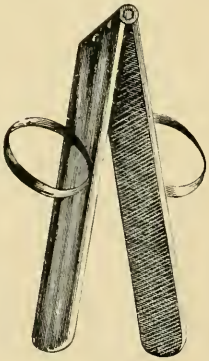

Fig. 269. — Finger clamps for grasping ovarian ligament (Colin).

Fig. 267. — Metal fingerstall for scraping through the ovarian ligament.

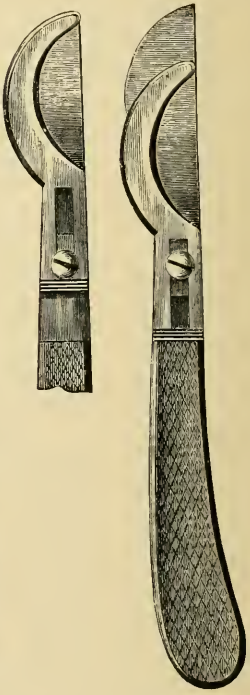

Fig. 270.—Guarded bistoury for incising upper wall of vagina (Colin).

large to admit the index and middle fingers into the abdomen. The ovaries were drawn towards the opening and were snipped off with scissors. In twelve cases healing was uninterrupted, but in one lamb an abscess occurred at the point of operation.

Hering castrated six two-year-old sheep from the flank for the purpose of discovering whether the yield of wool would prove greater after operation. In two only the left ovary could be reached. The operation was well borne, though it failed in its object. The animals fattened earlier than their fellows.

Fig. 268.—Forceps for grasping ovarian ligament when performing torsion of the ovary (olin).

3. Mares are only castrated for nymphomania, a disease which appears to be more frequent in coarse than in well-bred animals. Cadiot has frequently performed this operation during the past few years, and on the whole has had good results, although in some cases the object, viz. to render animals quieter and more tractable, has not been attained, a point to which Harms and Thomassen had previously directed attention. In mares, however, castration is always more difficult and more hazardous than in cows.

The principal danger consists in the well-known sensitiveness of the horse's peritoneum. The difficulties consist partly in the fact that irritable and well-bred animals can seldom be operated on in the standing position, this only being possible, as a rule, in coarse-bred horses, which can be restrained in a trevis. Furthermore, in the mare the ovaries are much further removed from the vulva, and the ovarian ligament is shorter than in the cow, so that it is impossible to draw the ovaries into the vagina, in order to effect torsion. The operator therefore has to introduce both the hand and the instrument into the peritoneal cavity, necessitating a much larger vaginal wound.

In the standing position the operation resembles that in the cow. Should a trevis not be at hand the hind limbs must be fastened with ropes, and a couple of strong poles or a strong sack be held under the body to prevent the mare lying down. The rectum must be entirely emptied. Hard fæces in the rectum are liable to cause injury to the bowel when the vagina is incised. As in the cow, the vaginal wall is divided above the os uteri, after preliminary cleansing and disinfection of the vagina, the vulva, and its neighbourhood. The injection of irritating fluids into the vagina must be avoided. Even 1 per cent. sublimate solution, especially if used warm, irritates the mucous membrane considerably, and causes straining, which interferes with

operation. The best disinfectant is a cold 2 per cent. solution of lysol or creolin. After perforating the vagina, the right hand is introduced into the peritoneal cavity, and the ovary sought for below the last lumbar vertebra, close to the external angle of the ilium, where it lies among the folds of intestine. In mares suffering from nymphomania the ovaries are often as large as a duck's egg. They can be distinguished by their firm consistence and their mobility. The left ovary is grasped with the right hand, and a long écraseur having been introduced with the left hand, the chain is thrust over the ovary, a somewhat difficult manœuvre. The operator steadies the écraseur with the left hand, whilst an assistant turns the screw, and so tightens the chain. At this stage the operator must make sure, by feeling with the right hand, that

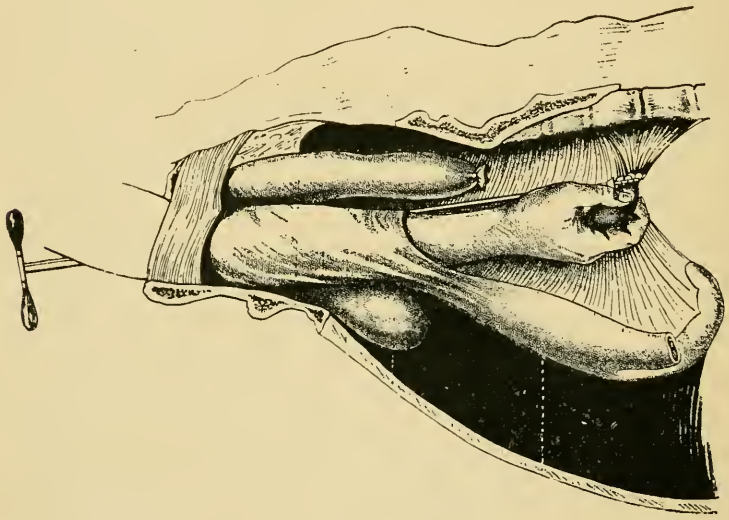

Fig. 271.—Ovariotomy with the écraseur (Cadiot's method).

no portion of bowel is included in the loop of the écraseur. As soon as the chain begins to divide the ovarian ligament it encounters greater resistance, and the screw should be turned more slowly until the ovary falls into the operator's hand, whereupon it and the écraseur are retracted. After similarly removing the right ovary (the left hand here replaces the right) the operator endeavours to withdraw any extravasated blood from the vagina by means of the hand. The animal is then placed in a quiet, well-bedded stall, with the hind quarters on a somewhat higher level than the fore. After-treatment is similar to that in cows.

In the mare the use of the écraseur is undoubtedly preferable to torsion of the ovarian ligament with forceps, the risk of injuring the

bowel being much less. The écraseur must be considerably longer and stronger than those in common use ; Delamotte uses one twenty-four inches in length. The chain or wire of the écraseur must also be stronger, otherwise it is very liable to break.

The operation becomes much more difficult when the animal has to be cast ; to prevent the straining which always occurs under these circumstances, deep anæsthesia is necessary ; otherwise the operation is as above described. A few mares were operated on in this way at the Berlin Veterinary College during the writer's period of study there. One was an emaciated experimental animal with a short

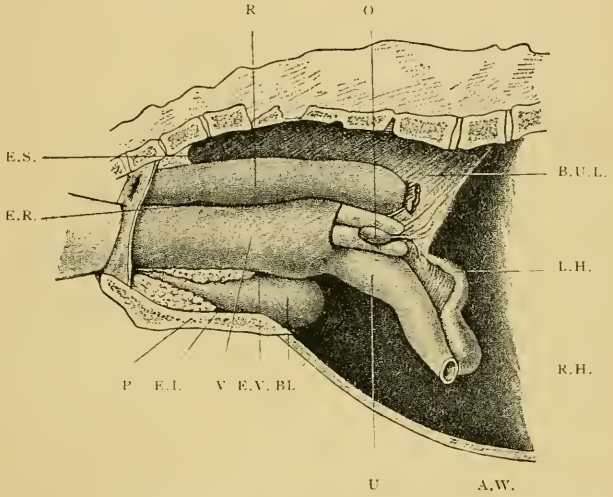

FIG. 272.—Longitudinal incision in a vertical plane through the posterior abdominal region, pelvis, and urino-genital organs of a cow. The section is somewhat to the right side of the median plane. The figure illustrates the second stage of ovariotomy : the hand is grasping the left ovary.

O. Ovary. U. Uterus. V. Vagina. R.H. Right horn of the uterus (cut through). L.H. Left horn of uterus. B.U.L. Broad uterine ligament. R. Rectum. BL. Bladder. P. Pelvis. A.W. Abdominal wall. E.S. Excavatio superior. E.R. Excavatio recto-vaginalis. E.V. Excavatio vesico-vaginalis. E.I. Excavatio inferior.

croup, in which operation proved comparatively easy. The next was a more powerful animal with a longer croup, and could only be castrated after deep chloroform anæsthesia. Though very difficult, the operation succeeded. During the following few days there was little disturbance, and the animal eventually proved cured. Cadiot places the animal in a trevis, which is a great advantage. He adopts Colin's method of cutting through the peritoneum, and condemns the suggestion to divide it with the fingers, on account of the serosa dissecting off and forming a pocket. Cadiot's general procedure

resembles that in cows, but he lays special stress on disinfection of the vulva and vagina. The parts are injected and washed with 3 per cent. creolin solution daily for two or three days before operation. He also draws attention to the fact that immediately after operation animals are apt to show colic, which continues from two to four days. He condemns irrigation of the vagina after operation.

Castration of cows and mares is apt to be followed by chronic inflammation and suppuration in the neighbourhood of the vagina, which may continue for months, and even prove fatal. Adhesions may also occur between the vagina and bowel or wall of the abdomen, and lead to twist of the bowel, with fatal results. Bourgès saw a mare die of twisted intestine caused in this way three months after castration. Delamotte reports the case of a mare in which abscess formation followed castration. Luckily the abscess discharged into the vagina, and recovery occurred.

4. The castration of sows is gradually being discontinued. The improved races of swine exhibit sexual appetite to a less degree than the old breeds. They remain on heat for a shorter time, and their fattening suffers little in consequence, so that castration has become more or less superfluous. The operation is not difficult, but requires much practice, and is seldom performed by veterinary surgeons. However, as the veterinary surgeon must have at least a theoretical acquaintance with it, a short description of the method is appended.

It is usually performed at the age of four to eight weeks—seldom in old breeding sows, although they bear the operation well—but must not be performed while the animal is on heat. The best time for castrating old animals is from four to six weeks after parturition.

In swine the ovaries hang from the long bowel-like horns of the uterus, which possesses no distinct neck or mouth, for which reason it is possible to reach both ovaries from one flank, or to introduce a director into the uterus, and by thrusting the organ towards the linea alba to remove the ovaries from the abdominal floor. For this reason two methods of operation are in use, one from the flank and one from the lower wall of the abdomen. The first is practised as follows :

The animal is placed on the right side, with the head and neck on the ground, and the hind quarters lying in front of the left knee of the operator, who sits on a stool. The hind legs are held extended backwards under the operator's left arm by an assistant, whilst the operator himself presses the animal's head and neck on the ground with his right foot.

The knife usually employed has a short broad blade, with a rounded

cutting edge, and is unprovided with a spring, so that it can easily be opened or shut with one hand. After clipping away the bristles the primary incision is made in the left flank, about $1\frac{1}{4}$ to $1\frac{3}{4}$ inches in front of the outer angle of the ilium, in the direction of the outer abdominal muscle, that is, from above forwards and downwards. Other operators make it at right angles to the vertebral column. The opening must be sufficiently large to permit of the right index finger being introduced, and the abdominal muscles and peritoneum being pierced. During an inspiration, or at the moment when the pig squeals, the finger is suddenly thrust through the abdominal tunics, thus preventing the peritoneum dissecting away from the abdominal wall, which would not only render the operation difficult, but might also lead to troublesome sequelæ. With the index finger in the abdominal cavity, the operator first secures the left ovary, which is the size of a bean, of firm consistence, and lies nearly equidistant from the external angle of the ilium and the middle line of the sacrum. When the ovary or the uterus is grasped the animal usually squeals, a fact of considerable importance in guiding the operator. The left ovary is drawn outwards and held by the right hand, whilst the index finger and thumb of the left hand gradually bring the left horn of the uterus into the wound, and finally into the right hand. As soon as the point of union of the two uterine horns becomes visible, the operator draws forward the right horn, together with the right ovary, in a similar fashion. Both ovaries are now nipped or torn off with the finger nail, or cut off with a knife. In young animals the entire uterus is often removed without bad effect. In older sows only the ovaries are removed, and care must be taken not to draw forward the body of the uterus. The uterine horns are then returned to the peritoneal cavity, the skin wound is sutured, and the animal placed alone in a clean, cool stall. During the ensuing twelve hours it should only receive clean water or small quantities of readily digestible food. On the following days gentle exercise may be given.

Many modifications of these methods have been suggested. Thus the operation may be performed with antiseptic precautions, which, however, experience shows to be unnecessary. In older sows, the abdominal muscles are also cut through, leaving only the peritoneum to be divided with the finger. Should the operator attempt to divide the muscles by means of the finger in such animals, a pocket is formed into which a coil of intestine may pass, become adherent, and cause death, either from peritonitis or from incarceration. In such cases the operator is often erroneously blamed, it being thought that he has sutured the bowel to the abdominal wound.

Beginners are advised to perform one or two experimental operations in order to gain some experience, otherwise they may be unable to find the ovaries. The extreme dexterity which can be attained, however, is shown by the professional castrator. Bowman, for a wager, castrated 100 sows in 160 minutes.

Castration from the white line is less frequently performed, though for unpractised operators it is easier than the former. The animal is hung up by its hind legs, or placed on its back on a table, and a bent director, the shape of a very elongated S, and about ten inches long, is passed along the upper wall of the vagina and uterus, so as to avoid the meatus urinarius. The director is pressed against the lower abdominal wall, about two inches in front of the anterior edge of the os pubis. A special spade-shaped knife is then passed through the abdominal wall, either towards the outside of the last left teat, or close to the linea alba. With the help of a blunt hook, the uterus is then found from this point, a comparatively easy task, inasmuch as the organ can be pressed towards the opening by means of the director previously introduced. With the uterus as a guide, one of the horns is discovered and the ovary removed; the second is operated on in a similar fashion. The skin wound is closed with button sutures, and usually heals by primary intention in five to six days. After-treatment is as above described.

The most important sequelæ to be dreaded are fatal bleeding and peritonitis. Death from bleeding seldom results after the first twenty-four hours, but peritonitis may prove fatal within a period of from three to thirty-six days. Such results are favoured by the custom observed in some places of driving swine soon after castration. Fatal bleeding is best prevented by nipping or twisting off the ovary; peritonitis by observing antisepsis, as in all operations on the peritoneal cavity.

5. Castration of bitches is seldom performed, and only for the purpose of avoiding inconvenience caused by the animal coming on heat. When young, and not too fat, these animals appear to bear operation well. The manipulation is more difficult than in swine, and can only be mastered by considerable practice, especially when the operation is performed from the flank, as in swine. In the bitch, the ovaries lie much further forward, near the kidneys; they are small and enveloped in fat; the ovarian ligament is short.

The bitch may be secured like the sow, or may be laid on its side on a table. The incision is made about 1¼ inches from the external angle of the ilium, and the same distance from the transverse processes

of the lumbar vertebræ. It should be about $1\frac{3}{4}$ inches in length, and should follow the direction of the outer oblique abdominal muscle, which may be divided at the same time as the skin. In the event of the operator desiring to remove both ovaries from one side, which is only possible in small animals, the incision must not be made too far forward. On the other hand, when an incision is made on either side, each may be placed somewhat further forward.

The abdominal wall is pierced with the index finger of the right hand as in swine, and the finger is passed towards the under surface of the fifth or sixth lumbar vertebræ in order to find the ovary, which is the size of a bean, and lies close behind the kidney. Though the ovary may not be found, the horn of the uterus is almost immediately encountered and should be drawn forward, when the ovary will be discovered, and can be nipped or cut off. By utilising the left horn of the uterus, the right may also be drawn forward and the ovary removed in a similar way. Both horns of the uterus are then returned to the peritoneal cavity, and the skin wound is sutured.

To prevent the peritoneum stripping away from the abdominal wall and forming a pocket, some operators, after dividing the outer skin and abdominal muscles with a knife, perforate the peritoneum with a director instead of with the finger. The director is then thrust into the abdominal cavity, and the opening enlarged by passing the knife along its groove. This prevents injury to the bowel.

It is often difficult to draw forward the right ovary, especially if the incision be made far forward. Some of the most experienced operators recommend making a second incision in a similar position on the right side, and repeating the process.

Castration from the linea alba is easier for beginners, and is performed as in swine. When, however, the udder is well developed, or the animal is old, difficulties arise. The animal is placed on its back on a table and anæsthetised. A strong director, with a slightly bent end, is passed along the upper wall of the vagina into the uterus. It is certainly not so easy to introduce as in swine, but the difficulty is overcome by pressing the end of the director towards the upper wall of the vagina. Arrived in the uterus, the end is then turned towards the lower abdominal wall, so that its presence can be recognised about $1\frac{1}{4}$ to 2 inches in front of the edge of the os pubis. At this point an incision $1\frac{1}{4}$ to 2 inches in length is made close to the linea alba, the peritoneum is pierced with the finger, and with the help of the director the uterus is discovered; from this the ovaries are easily found, and can be removed by torsion, or by nipping or tearing off. The skin wound must be carefully sutured and treated antiseptically.

It has been suggested that in young animals a double ligature might be applied close behind the point of bifurcation of the uterus, and the organ divided between the two ligatures without the operator troubling to discover the ovaries. Whether this would destroy the sexual appetite or only the reproductive powers seems doubtful.

Several German veterinary surgeons recommend operating in the linea alba, breaking through the broad uterine ligament, and cutting off the ovaries after ligation with catgut. The abdominal muscles are united with catgut, the skin with silk, and a surgical dressing is applied by means of a bandage enveloping the whole body.

6. Castration of birds consists in dividing the oviduct. The birds are held by an assistant as in caponing, and an incision about $\frac{3}{4}$ to $1\frac{1}{4}$ inches in length, and about the same distance from the anus, is made through the abdominal wall. The disinfected forefinger is introduced, the rectum thrust to one side, and the oviduct, which lies below the rectum, and can be recognised by its white colour, is grasped with forceps. The duct is then drawn forward, and cut across with scissors about three quarters of an inch in front of its junction with the rectum. Some operators excise a portion. After returning the ends the wound is sutured as was described in connection with caponing.

By slowly exercising pressure on the lower portion of the bird's body the oviduct can be forced outwards through an incision made above the anus. It is then cut through, and the incision sutured.

During the ensuing three or four days the birds are kept apart in a cool quiet place, and receive light food.

Extirpation of the ovaries is dangerous in hens, and as castration by division of the oviduct is sufficient, ovariotomy is not practised.

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